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Areawide Waste Treatment and Water Quality Management Planning. Oilfield Brine A Survey of Land Damage in Hamilton County

Greater Egypt Regional Planning and Development Commission, Carbondale, IL

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Oil Field Brine: A Survey of Land Damage in Hamilton County, Phase I of the Areawide Water Quality Management Planning Program for Southern Illinois. The report was prepared under Section 208 of the Water Pollution Control Act as amended. It focuses on the acreage of oil field brine damaged land in Hamilton County, Illinois and relates the estimated soil loss from this land to the proximity of area streams. Its purpose is to verify the potential for sources of major sediment and chemical contaminants directly related to oil production regions.

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Oilfield Brine: A Survey Of Land Damage In Hamilton County

Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson Counties, Illinois

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

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Areawide Waste Treatment And Water Quality Management Planning

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Oilfield Brine: A Survey Of Land Damage In Hamilton County

Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson Counties, Illinois

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GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

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December, 1980

William Kelley, Chairman
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Lloyd Williams, Chairman
Southeastern Illinois Regional Planning
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Transmitted herewith is the Oil Field Brine: A Survey of Land Damage in Hamilton County report. This document addresses soil loss and severe erosion problems as they relate to brine damaged lands in Hamilton County.

The report is an integral part of the Water Quality Management Planning Program, and refines issues developed in the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. It is designed to meet the contract requirements of Federal Grant P005461-01 with the United States Environmental Protection Agency.

We trust the submittal of this report, as well as others comprising the 208 program will document the continuing planning activities for water quality management.

Sincerely,

A. S. Kirkikis
Executive Director

ASK:jl

i.b

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The Rend Lake Conservancy District

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I. INTRODUCTION

The Federal Water Pollution Control Act (Public Law 92-500) asserts that each state should administer its own water quality program in compliance with the Act and national program. In response to this designation, in 1975, the Governor of the State of Illinois designated the ten counties served by the Greater Egypt Regional Planning and Development Commission and the Southeastern Illinois Regional Planning and Development Commission as the Southern Illinois Water Quality Management Area. It was felt that these ten counties: Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline and Williamson, which encompass almost the entire Big Muddy and Saline River Basins, had factors affecting water quality which made the area unique in the state and should be addressed locally.

In early 1979, the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois was finalized and submitted to the Illinois Environmental Protection Agency and the U. S. Environmental Protection Agency. Since that time a myriad of counties, municipalities, soil and water conservation districts and river conservancy districts have endorsed and participated in implementing the Plan. This report documents the findings of the initial Plan and the continuing planning process under Section 208 of the Federal Pollution Control Act as amended. This report specifically addresses the impact of oil field brines upon water quality in the Region.

With a thorough understanding of activities which have the greatest impact on surface water quality, effective programs for long range protection of this resource can be developed. Pollution sources such as agricultural related sedimentation, irrigation, and industrial and municipal waste disposal have received primary research attention. Other significant sources such as oil field brine disposal; brine surface impoundments; buried pipelines and storage tanks; abandoned oil, gas and water wells also require special attention if an effective water quality protection plan is to be implemented. A source of surface water contamination investigated under the initial areawide 208 water quality management plan was surface or land damage attributed to improper disposal of oil field brines.

Definition of Terms

The following terms are used throughout this report.

Damaged Land: A surface area which has been rendered void of vegetation because of oil field brine contamination.

Affected Land: A surface area which grows only limited vegetative cover because of oil field brine contamination. These lands also include damaged lands.

Intermittent Vegetation: Patches of vegetation at the perimeter of, or inside damaged areas which are repeatedly destroyed by influxes of brine contaminated water and soils.

Section: A land area equal to one square mile (640 acres).

Identification of Problem

In the initial planning program, brine related surface damage attributable to petroleum extraction was identified as a potential source of water pollution. During the beginning stages of project development, two separate factors hinted toward a petroleum related water quality problem in the 208 area. The first came from findings by the Illinois Environmental Protection Agency (IEPA) that several area streams had violated chloride concentration standards.[1] The Illinois EPA had found that most of those streams which had chloride violations also had petroleum extraction activities occurring in their watersheds.

Further awareness of the problem came from an oil field brine damaged land assessment by the district conservationist for the Hamilton County Soil and Water Conservation District. In 1978, it was estimated that there were about 900 brine damaged sites. In addition, soil erosion losses on some sites were considered to easily exceed 70 tons per year, and that losses of 30 tons per year would not be uncommon. An initial map was prepared which identified the severely salt damaged areas in Hamilton County. Based on these initial estimates of affected lands and soil erosion loss, it was evident that a problem existed and warranted further investigation.

The focus of the work reported here is to further delineate the nature and extent of the problem of actual and/or potential brine related input to the streams and reservoirs in Hamilton County. This effort is in keeping with national priorities for the Clean Water Act, and may assist in facilitating possible federal cost sharing for operational control programs.

An explanation of the geologic origin of oil field brine is presented in Appendix A.

II. HISTORY

Discovery of Oil in Illinois

The first oil fields in Illinois were discovered around 1903 in Lawrence and Crawford counties. Since the initial period of peak production from these oil fields in 1910, annual production has fluctuated drastically with changes in technology and the economy. A peak in annual oil production of 146.8 million barrels resulted from the post-1937 Mississippian discoveries.[2] Since then, rates have decreased to 26.3 million barrels according to 1976 statistics.[3]

It has been reported by the Illinois State Geological Survey that early oil field brine disposal practices consisted of siphoning the brine from an earthen holding pond directly into a cased well.[4] Since gravity was the only injection force utilized, this type of facility was usually abandoned as the permeability of the receiving formation diminished to a point where free flow was restricted. This posed no particular problem in that another well in the approximate area could generally be found and readily converted to meet disposal needs. In subsequent years, technology progressed as did the amount of brine produced. With the development of modern secondary recovery techniques, injection pressures of several hundred pounds per square inch were commonly applied, thus dramatically increasing the ultimate capacity of a typical injection well.

The more significant problems involved in these disposal operations are due to the relatively high density and corrosive nature of the oil field brines and their damaging effects upon land and water. These problems can be compounded by the fact that as an oil field matures the ratio of brine to oil production may increase substantially. In fact, it is not uncommon for brine to oil production ratios to exceed 80:1.[5] The effects of large quantities of brine can be damaging unless oil well operators are equipped to safely dispose of or reinject the caustic waste.

Evaporation Pits and Early Injection Wells

Evaporation pits, introduced in Illinois from the southwestern oil producing states, rely solely or in part on evaporation for the removal of water vapor. These pits are used as ultimate disposal facilities, or storage facilities pending underground injection. However, the relatively humid climate of Southern Illinois allows little or no net evaporation throughout the year.[6] This suggests that evaporation pits in Illinois are capable of disposing of only small volumes of brine and are totally inadequate to handle the brine disposal requirements of a producing well.

New evaporation pits are currently required to be lined with impervious material (plastic, concrete or fiberglass) to guard against subsurface seepage of brine, whereas clay was prescribed as the lining material prior to 1973. The fact that these liners are not indestructible and do have a limited life expectancy indicates that the possibility of seepage is by no means eliminated. To cope with this problem the Illinois Department of Mines and Minerals is currently in the process of phasing out the old unlined evaporation and storage pits and requiring brine to be stored in corrosion resistant tanks. A deadline of 1984 has been set by the Illinois Department of Mines and Minerals beyond which no additional pits will be allowed.

III. OIL FIELD BRINE AND WATER POLLUTION

Sources of Pollution

In general, oil field brine related water pollution is the movement of soils and chemicals by either gravitational flow or forced injection into surface waterways and ground water aquifers. These pollutants can be naturally and continually occurring through geological process, except where abnormally high chemical concentrations accelerate the soil erosion process. During the initial field inspection the many ways which brine contaminates the land and water became evident.

During the two months of field work in the summer of 1980, several sources of brine pollution were observed. The six most easily recognized contributors to surface and ground water contamination are: 1) active and abandoned storage pits, 2) well sites and storage pits which have been leveled or released from bond, 3) leaking transport pipes and tank batteries, 4) accidental and intentional spills, 5) improperly managed brine disposal wells, and 6) brine affected and damaged land.

This last factor, damaged land, may be the greatest contributor of sediments and chemicals to area waterways. A study by the Illinois State Water Survey describes the water quality of three (3) streams located in southern Hamilton County. Of the three (3) streams tested Contrary Creek showed the greatest impact from oil operations.

This study found that "Contrary Creek contains the most highly mineralized waters of the three streams. About 38% of the time chloride concentrations exceed 500 mg/l; sulfate concentrations of 250 mg/l are exceeded 18% of the time; and 53% of the time total dissolved solids concentrations of 1,000 mg/l are exceeded. The main reason for the excesses, all exceeding water pollution control regulations, is oil well activity".[7]

Characteristics of Brine in Soil

These lands are unique in that they are either void of vegetation or are supporting limited plant growth with no appreciable canopy on a year round basis. Major changes in the soil chemistry are the inhibiting factors to plant growth. The changes are attributed to a monovalent cation, Sodium (Na^+). Na^+ acts as a neutralizer to negative clay particles, yielding a condition whereby clay particles neither attract nor repel each other. Consequently the soils' natural tendency to "take form" is lost and the soils settle, becoming extremely compact and virtually impervious to the percolation of water. These soils are held together by gravity and moisture. As the surface soils lose moisture they separate to individual particles, similar in consistency to powder, and are highly susceptible to wind and rain erosion.[8]

IV. IDENTIFICATION PROCEDURES

Aerial Photograph Interpretation

Technical assistance from the Hamilton County District Conservationist in both the field and office led to the development of a methodology for identifying brine damaged land on a county wide basis. A series of on-site field investigations was most helpful for understanding the unique characteristics of brine affected land. With general knowledge of storage pond profiles and surrounding features such as tank batteries and service roads, identification by aerial photography began. Soil Conservation Service (SCS) personnel gave thorough instructions on recognition of brine damaged lands on both black and white and color photographs. The most distinguishing features on aerial photographs were the barren lands and service roads.

These aerial photographs are standard Agricultural Stabilization and Conservation Service photos which all ASCS offices have. This project utilized both the black and white pictures from 1970 and the color slides from 1979. The pictures were set at an easily measurable scale of 1" to 660'. The more recent color slide was projected onto a photograph of the same land area set at the same scale. The major roads and brine damaged land were outlined on individual maps.

In order to identify areas of the county which may have contained poorly and partially regenerated damaged lands, a map of Hamilton County was made from Illinois State Geological Survey oil and gas development maps. This map indicated all the oil, gas and injection wells which were established from the beginning of oil and gas development to 1976.

From this map the sections with active or abandoned wells were identified and then inspected by using both the pictures and slides. Over 200 sections of Hamilton County were viewed and over 150 sections outlined onto additional maps. With these individual maps it was possible to develop a map which showed the concentration of brine damaged sites as well as areas which would have more extensive erosion problems (see Figure 1). Once the county was surveyed and the brine damaged lands outlined, a random sample of 40 sites was selected to represent the county.

The sample group was expected to answer the following questions:

1. What characteristics are unique to these lands as opposed to their unaffected surroundings?

2. What are the oil production related factors which degrade water quality?

3. What are the contributing factors that increase soil erosion losses?

The 40 sample sites with their site analysis material and erosion rate criteria are listed in Appendix B.

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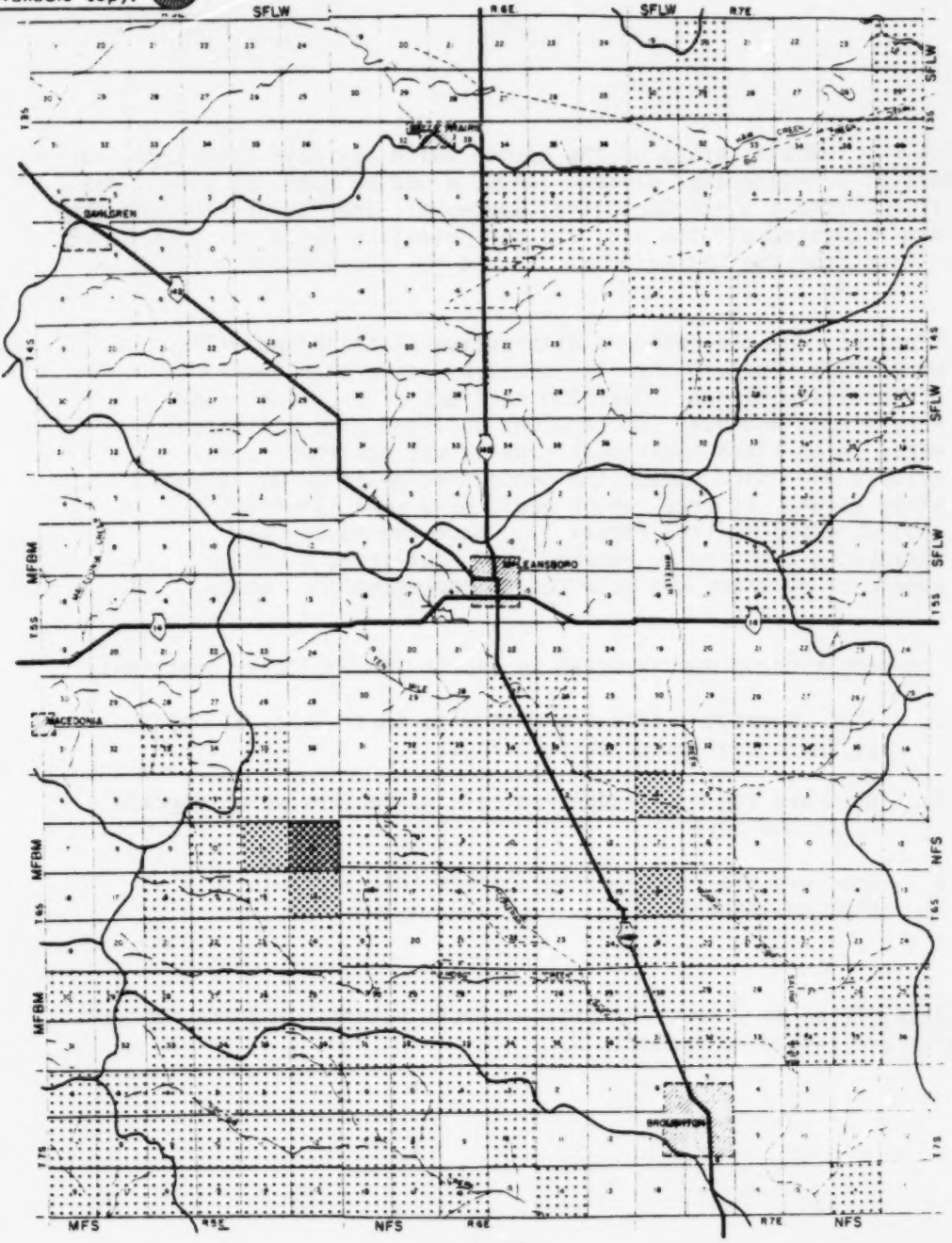

FIGURE 1

CONCENTRATION OF BRINE DAMAGED SITES IN HAMILTON COUNTY

N

Scale in Miles

0 1 2 3 4 5

LEGEND

- TOWNS & CITIES
- SECTIONS
- 1-22 DAMAGED SITES
- 23-44 DAMAGED SITES
- 45-111 DAMAGED SITES
- MAJOR HIGHWAYS
- STREAMS
- CHANNELIZED STREAMS
- WATERSHED BOUNDARIES
- MFBM MIDDLE FORK OF THE BIG MUDDY
- MFS MIDDLE FORK OF THE SALINE
- NFS NORTH FORK OF THE SALINE
- SFLW SOUTH FORK OF THE LITTLE WABASH

LOCATION IN ILLINOIS

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

V. UNIVERSAL SOIL LOSS EQUATION AS ADJUSTED FOR BRINE CONTAMINATED SOILS

The Universal Soil Loss Equation (USLE) is an erosion model designed to predict the long term average soil losses in runoff from specific field areas in specified land use and management systems. It computes the soil loss of a given site as the product of six major factors whose most likely value at a particular location can be expressed numerically. Erosion variables reflected by these factors vary considerably from their means from storm to storm, but effects of the random fluctuations tend to average out over extended periods. The severely damaged land dealt with in this project was estimated to have been in this condition for many years, if not decades; therefore, application of the USLE on brine damaged sites is considered valid according to soil scientists consulted.

Numerical values for each of the six factors were derived from field analysis in the research area and from consultation with soils specialists of Hamilton County and the soil conservation service. For the specific conditions of brine damaged land, adjustments in the K and C factor of the USLE were necessary.

Description of USLE Elements

The USLE is A = R K L S C P where A is the computed soil loss per unit area.[9] In this study A is expressed in tons per acre per year, R is the rainfall and runoff factor for the soil loss rate per erosion index unit for a specified soil as measured on a unit plot. For this particular region the numerical value of R is 220. R was not adjusted to compensate for the unique soils characteristics because of limited research. This figure quantifies the raindrop impact effect and must also provide relative information on the amount and rate of runoff likely to be associated with the rain.

K, the soil erodibility factor is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot. The special characteristics of brine affected land required the use of a nomograph to make proper adjustments in its value (see Figure 2). The nomograph is a tool used in determining a K value. It considers percent of organic matter, percent silt and sand, soil structure and permeability. For the purpose of this study it will be assumed that all salt affected soils, regardless of soil type, will have a K value of .55.

LS is the relationship between length and slope of the land. The two effects have been evaluated separately in research and are represented in the soil loss equation by L and S respectively. For the purpose of field application, combining the two into a single topographic factor LS was more convenient. Slope length is defined as the distance from the point of origin of overland flow to the point where either the slope gradient decreases enough that deposition begins, or the runoff water enters a well defined channel that may be part of a drainage network or a constructed channel.

The procedure in assessing brine damaged land required an adjustment in measurement techniques. It was evident that few, if any sites actually originated at the beginning point of overland flow. Therefore, in order to determine the soil erosion loss for a particular site, only the damaged surface was estimated.

P is the ratio of soil loss associated with a specific support practice to the corresponding loss with up and down slope culture. For no conservation practice a value of one (1) is used. After field inspection of salt affected land, it was obvious no conservation practices were being implemented; therefore, this is the value utilized on all sampled sites.

C is the ratio of soil loss from land cropped under specified conditions to the corresponding loss from clean-tilled, continuous fallow land. This factor measures the combined effect of all the interrelated cover and management variables. The loss that would occur on a particular brine damaged site is computed by the product of R K L S in the soil loss equation. C adjusts the soil loss estimate to suit the variable combination of cover, crop sequence and management practice.

In developing sufficient data to complete the USLE, each site was measured by dividing it into individual sheet and rill erosion divisions. These sites were usually barren and supporting only sparse or intermittent patches of vegetation.

After consulting with the soil conservation service, it was determined that a C factor of .8 would be appropriate for barren land in Hamilton County. The remaining lands fell into different categories with previously designated C values. These C factors were selected from the United States

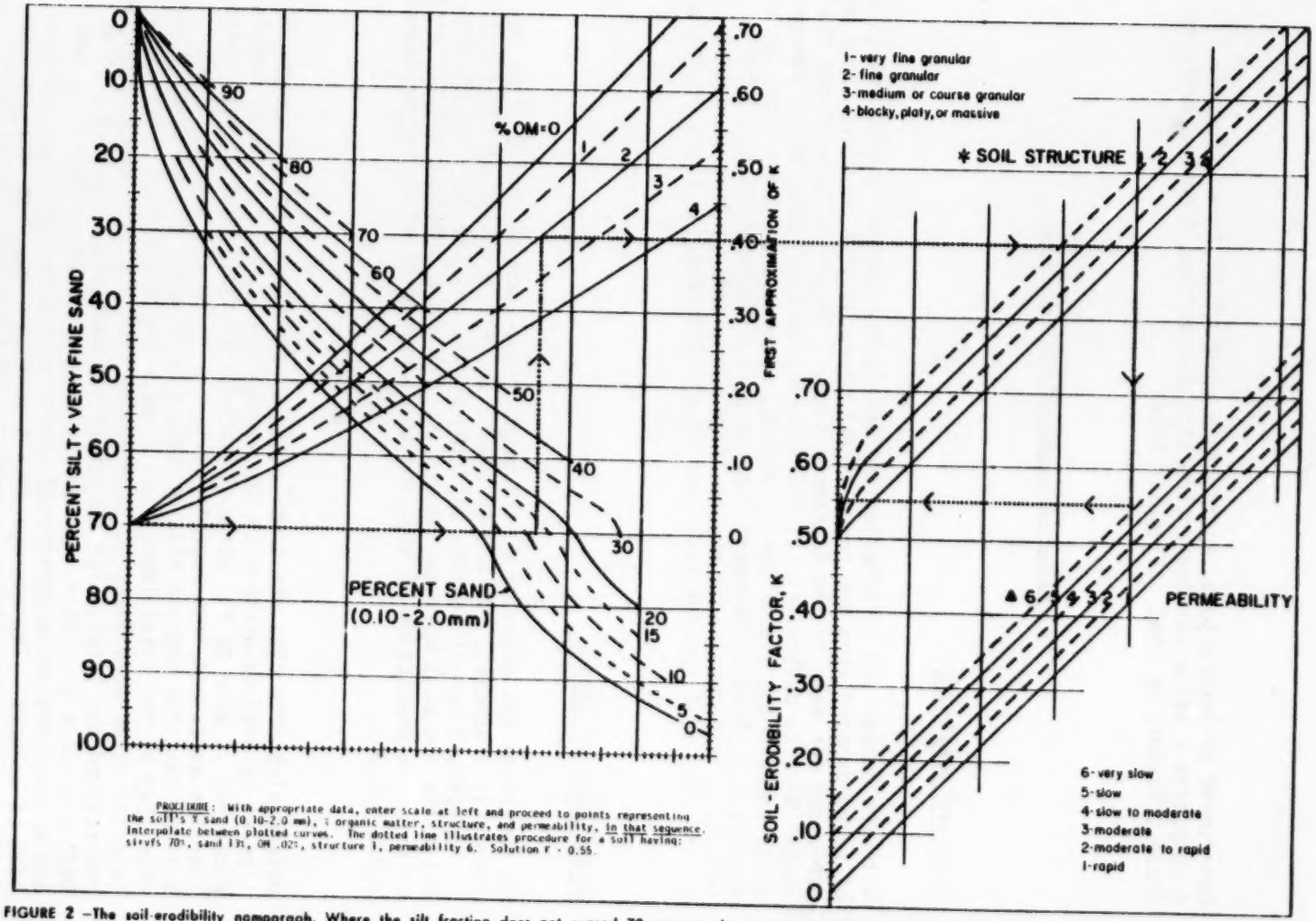
PERCENT SILT + VERY FINE SAND
PERCENT SAND
(0.10-2.0mm)
%OM=0
FIRST APPROXIMATION OF K
SOIL-ERODIBILITY FACTOR, K
* SOIL STRUCTURE
1- very fine granular
2- fine granular
3- medium or course granular
4- blocky, platy, or massive
▲ PERMEABILITY
6- very slow
5- slow
4- slow to moderate
3- moderate
2- moderate to rapid
1- rapid
PROCEDURE: With appropriate data, enter scale at left and proceed to points representing the soil's % sand (0.10-2.0 mm), % organic matter, structure, and permeability, in that sequence. Interpolate between plotted curves. The dotted line illustrates procedure for a soil having: si+vfs 70%, sand 13%, OM .02%, structure 1, permeability 6. Solution K = 0.55.

FIGURE 2 —The soil-erodibility nomograph. Where the silt fraction does not exceed 70 percent, the equation is $100\ K = 2.1\ M^{1.14}\ (10^{-4})\ (12 - a) + 3.25\ (b - 2) + 2.5\ (c - 3)$ where M = (percent si + vfs) (100 — percent c), a = percent organic matter, b = structure code, and c = profile permeability class.

Source: United States Department of Agriculture - Agriculture Handbook no 537 1978

Department of Agriculture, Agriculture Handbook #537 (see Appendix C). A composite C value for the entire site was derived from the averages of those C factors on that particular site.

VI. FIELD CHECK OF RANDOM SAMPLES

Proposed Questions

With the background information concerning the special characteristics of brine damaged land and their affect upon the USLE, a field check was conducted for each of the 40 sample sites. The objectives of the field checks were to determine: 1) the accuracy in predicting brine damaged sites through the use of aerial photos, 2) an average site size, 3) an average soil loss or movement from an acre of damaged land, 4) the relationship between soil erosion from brine damaged land and total county wide soil erosion loss, and 5) critical erosion sites or regions.

Statistics or Data

To determine the accuracy in the prediction, each of the 40 sites was carefully inspected. Of the 40 sites, 36 were actually brine affected or damaged, 3 were livestock watering ponds, and the last was an area where the top soil has been removed to fill in a drainage ditch. With an error in prediction of ±10%, the total number of sites ranges between 1,930 - 2,359.

Determining site size was complicated by the largely disproportionate size of several selections in the random sample. The range of sample sizes was .1 acre to 9.7 acres. Fourteen of those sampled were larger than one acre, and from experience in the field and office, it was evident that the average size of this sample would be appreciably larger than that of the total identified sites. Therefore, 1,400 randomly selected sites were measured in order to find a figure which more accurately represented the total. The technique for measuring involved a 1" to 660' dot scale on a card. With maps already drawn at the 1" to 660' scale, the card was superimposed over the area and each dot represented 1/10 of an acre. The average site size figure was then changed from 1.65 acres for the original sample to .77 acres for the sample of 1,400 sites.

Critical adjustments in the USLE factors were required in order to make it a more accurate determinant of soil loss or movement. While field checking the sample sites (as well as many others) staff observed several changes occurring which had an affect on estimating sheet and rill erosion divisions. One observation was that small patches of vegetation existed in areas surrounded by barren soils. These patches were to be included in the no appreciable canopy sheet and rill division. In other cases these patches had been destroyed by an influx of brine contaminated soils or water. These patches, even though visible traces of organic matter existed, were classified as barren. Another change on many sites was the evidence of increasing size. (As contaminated soils and water run off a site, they collect at the point where flow stops.) At this point, contamination of soils which had supported vegetation occurs, and plant growth is inhibited. Most of these areas were classified as barren.

With a clear understanding of how brine affects soils and increases the soil erosion loss, measurements of this change were begun. For the 36 sample sites an average soil erosion loss of 40 tons per acre per year was derived. (For sample site location, maps, descriptions and soil erosion loss data, see Appendix B.)

The average soil erosion loss for the general land uses in Hamilton County is estimated at 5.7 tons per acre per year. When compared on a county wide basis brine damaged land consists of .5 - .8 percent of the county or between 1,487 - 2,359 acres. This land has the potential of producing 3.5 - 5.7 percent of the county total soil erosion loss, or between 59,480 - 73,360 tons of soil per year. These figures represent the severely damaged land and not the less affected land or the service roads. These affected lands with their slower growth characteristics could double, if not triple, the total brine related erosion loss figure for the county as a whole.

VII. CONCLUSIONS AND RECOMMENDATIONS

1. Field studies verified the differences between brine damaged and brine affected lands.

2. Soil consistency is drastically altered by brine in that the soil particles neither attract nor repel one another. This condition causes the soils to erode more rapidly.

3. Field study of land features combined with aerial photograph interpretation is an effective means of identifying brine damaged land on a county wide basis.

4. Correct use of nomograph and accurate estimates of ground cover aid the Universal Soil Loss Equation in measuring the soil erosion loss or movement on brine damaged land.

5. It was determined that the average size of a brine damaged site was .77 acres. The average soil erosion loss as estimated with the Universal Soil Loss Equation was over 40 tons per acre per year.

6. Approximately .6% of Hamilton County has been severely damaged by exposure to oil field brines. This same area has the potential to yield approximately 76,420 tons of soil per year. Note that less than 1% of the county's land area is producing 4% of the county's soil erosion.

7. The county soil and water conservation districts should consider targeting special management practices to damaged lands. An operational control program for reclamation of existing sites and minimizing damage to future sites should be developed jointly by the areawide 208 agency and the county soil and water conservation districts in conjunction with the Illinois Environmental Protection Agency, the Illinois Department of Mines and Minerals, and other involved agencies.

   On a broader scale, the areawide 208 agency should provide methodology and procedures to area soil conservation service and soil and water conservation district personnel for identifying damaged lands and assessing erosion potential of those lands. The areawide agency should provide public participation activities targeting solutions to the problem of land damage,its resultant erosion and impact upon area water quality. Public presentations of reclamation methodologies, including tours of reclaimed sites, should be carried out.

   Cost-effective analyses of various reclamation approaches should be conducted to assure that most cost-effective methodologies for upgrading water quality are utilized. While reclaiming land to productive row crop may be too costly, other reclamation techniques may result in at least securing the land and decreasing erosion based water quality degradation originating from brine damaged lands.

   Procedures for filing complaints and seeking remedies should be publicized through areawide agency activities. Information and procedures should be disseminated through the Regional Water Quality Coordinating Council and local management structures.

Finally, an assessment of the adequacy of new well bonds to cover potential damage should be conducted.

The above recommendations, if implemented in a Phase II project, should result in institutionalizing within local government management agencies an on-going approach to solving a major water quality problem.

REFERENCES

[1]Greater Egypt Regional Planning and Development Commission, Areawide Waste Treatment and Water Quality Management Planning: Appendix B-1, Nonpoint Sources of Water Pollution. Publication No. GERPDC 78-486, 1978.

[2]State of Illinois Department of Registration and Education, State Geological Survey Division, Size, Development and Properties of Illinois Oil Fields by R. F. Mast, Illinois Petroleum 93, 1970.

[3]State of Illinois Department of Registration and Education, State Geological Survey Division, Petroleum Industry in Illinois, 1976 by J. Van Den Berg and T. F. Lawry, Illinois Petroleum 12, 1977.

[4]State of Illinois, Department of Registration and Education, State Geological Survey Division, Brine Disposal in Illinois by A. H. Bell, Circular 244, 1957.

[5]IBID

[6]Illinois Environmental Protection Agency, Water Quality Management Plan, Vol. II, 1979.

[7]Thomas A. Butts, Jack W. Williams, Ralph L. Evans, Water Quality Evaluation of the Rector Creek - North Fork Saline River Drainage Basins, Illinois State Water Survey, 1976.

[8]William D. Burke, District Conservationist, Hamilton County Soil and Water Conservation District, Personal Communication.

[9]Walker, Robert D., and Pope, Robert A., Estimating Your Soil Erosion Losses with the Universal Soil Loss Equation, Cooperative Extension Service, College of Agriculture, University of Illinois, Urbana, Illinois, 1979.

[10]State of Illinois, Department of Registration and Education, State Geological Survey Division, The Origin of Saline Formation Waters, III Calcium Chloride Water by D. L. Graf, W. F. Meents, I. Friedmen, N. W. Shimp, Circular 397, 1966.

[11]IBID

[12]IBID

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BIBLIOGRAPHY

Greater Egypt Regional Planning and Development Commission. Areawide Waste Treatment and Water Quality Management Planning: Appendix B-1, Nonpoint Sources of Water Pollution. Publication No. GERPDC 78-486, 1978.

Illinois Environmental Protection Agency. Water Quality Management Plan, Vol. II, 1979.

L. H. Hileman, Reclaiming Land Polluted by Brine From Oil Fields. Agricultural Experiment Station, University of Arkansas, 1972.

L. H. Hileman, Using Poultry Manure Compost to Reclaim Salt Polluted Soils. University of Arkansas, Agronomy Department, 1972.

L. H. Hileman, Gerald Crossland, Emily Burr, Performance of Compost in Reclaiming Salt Damaged Soils. University of Arkansas, Agronomy Department, 1977.

State of Illinois, Department of Registration and Education, State Geological Survey Division. Size, Development and Properties of Illinois Oil Fields by R. F. Mast, Illinois Petroleum 93, 1970.

State of Illinois, Department of Registration and Education, State Geological Survey Division. Petroleum Industry in Illinois, 1976 by J. Van Den Berg and T. F. Lawry, Illinois Petroleum 12, 1977.

State of Illinois, Department of Registration and Education, State Geological Survey Division. Brine Disposal in Illinois by A. H. Bell, Circular 244, 1957.

State of Illinois, Department of Registration and Education, State Geological Survey Division. The Origin of Saline Formation Waters, III Calcium Chloride Water by D. L. Graf, W. F. Meents, I. Friedmen, N. W. Shimp, Circular 397, 1966.

Thomas A. Butts, Jack W. Williams, Ralph L. Evans, Water Quality Evaluation of the Rector Creek - North Fork Saline River Drainage Basins. Illinois State Water Survey, 1976.

Walker, Robert D., and Pope, Robert A., Estimating Your Soil Erosion Losses with the Universal Soil Loss Equation. Cooperative Extension Service, College of Agriculture, University of Illinois, Urbana, Illinois, 1979.

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Raymond Herman, U. S. Soil Conservation Service, State Office, Springfield, Illinois. Personal Communication.

Dr. Stan Lieber, Southern Illinois University - Carbondale, Geography Department. Personal Communication.

William D. Burke, District Conservationist, Hamilton County Soil and Water Conservation District. Personal Communication.

Appendix A

SUMMARY OF GEOLOGIC ORIGIN OF ILLINOIS OIL FIELD BRINE

Initial Fluid Content

The fluid produced from a typical oil well in Illinois is composed primarily of salt water with varying amounts of petroleum particles held in suspension. After extraction of the fluid from producing formations, petroleum particles are separated for storage. The remaining salt water, or oil field brine, is then disposed of through use of evaporation pits or injection wells.

Brine Formation

There are several hypotheses for the formation of Illinois Basin brines with varied degrees of acceptance by different researchers in the field. One hypothesis proposes a derivation from original sea water with a minor contribution of fresh water.[10] Even though the brine originated from sea water initially incorporated in the sediment, subsequent compaction of the constituents produced greater concentrations. For comparation purposes, the surface water closest in composition to these subsurface brines is that of the present day Dead Sea.

Brine Characteristics

Brine salinity is primarily a function of the sulfates (SO_4^{-2}), bicarbonates (HCO_3^{-1}) and chlorides (Cl^{-1}) of the cations sodium (Na^{+}), calcium (Ca^{+2}) and magnesium (Mg^{+2}).[11]

Brine in the Illinois Basin

The underlying geology known as the Illinois Basin covers approximately 135,000 square miles of the south central and southeastern portions of

Illinois and extends into southwestern Indiana and western Kentucky. Studies on the concentration of total solids present in Illinois Basin brine reveal that the greatest concentrations are centrally located within the Basin as reported by Meents and others. Concentrations diminish radially outward and seem to conform to the contours of the Basin. Brine concentrations of other formations vary slightly, but all seem to exhibit similar structural dependencies.[12]

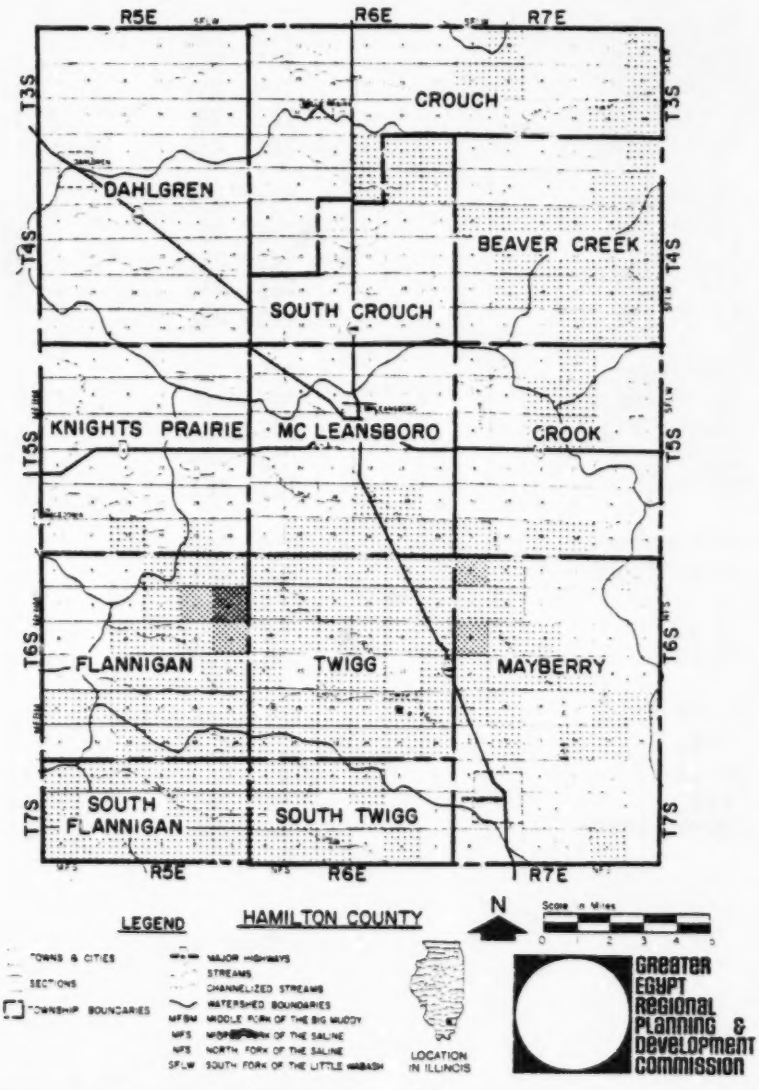
Note: The above information was taken from Illinois Oil Field Brine Disposal Assessment (IEPA Staff Report 1979).

Appendix B

SURVEY DATA FOR 40 RANDOM SAMPLE SITES

Site #	Township	Township/Range	Section
30	South Flannigan	T7S R5E	18
91	Flannigan	T6S R5E	16
128	Flannigan	T6S R5E	21
142	Flannigan	T6S R5E	28
154	Flannigan	T6S R5E	28
182	South Flannigan	T7S R5E	4
250	Flannigan	T6S R5E	12
321	Flannigan	T6S R5E	12
366	Flannigan	T6S R5E	11
370	Flannigan	T6S R5E	11
497	Flannigan	T6S R5E	13
546	Flannigan	T6S R5E	13
583	Flannigan	T6S R5E	24
588	Flannigan	T6S R5E	24
685	Flannigan	T6S R5E	26
731	Flannigan	T6S R5E	36
942	South Twigg	T6S R6E	17
984	South Twigg	T6S R6E	31
1009	Crouch	T4S R6E	3
1016	McLeansboro	T5S R6E	27
1030	McLeansboro	T5S R6E	27
1078	McLeansboro	T5S R6E	34
1116	Twigg	T6S R6E	4
1132	Twigg	T6S R6E	3
1163	Twigg	T6S R6E	10
1272	South Twigg	T7S R6E	3
1362	Twigg	T6S R6E	1
1393	Twigg	T6S R6E	12
1403	Twigg	T6S R6E	12
1555	Beaver Creek	T4S R7E	20

Site #	Township	Township/Range	Section
1568	Crook	T5S R7E	31
1576	Mayberry	T6S R7E	6
1584	Mayberry	T6S R7E	6
1586	Mayberry	T6S R7E	6
1612	Mayberry	T6S R7E	6
1639	Mayberry	T6S R7E	6
1647	Mayberry	T6S R7E	6
1744	Mayberry	T6S R7E	18
2061	Beaver Creek	T4S R7E	23
2110	Mayberry	T6S R7E	26



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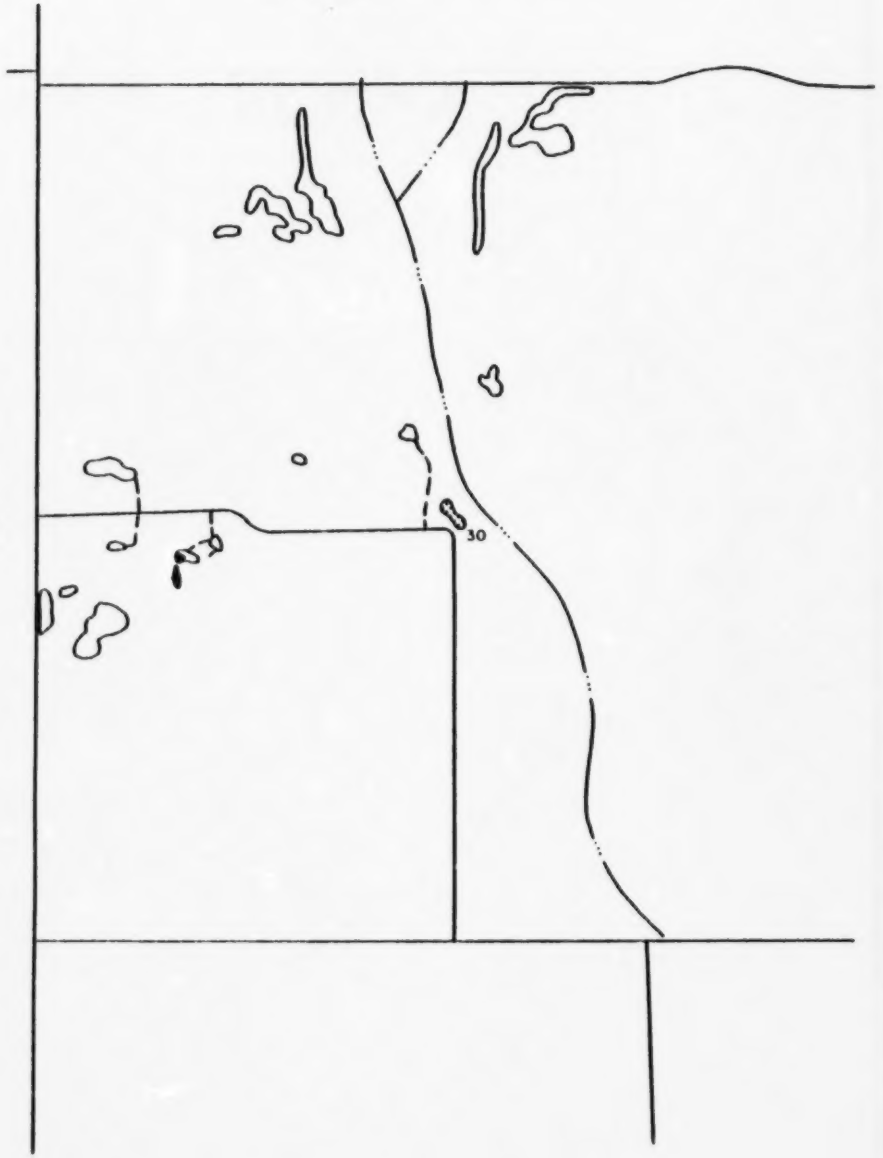

T7S-R5E Section 18

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N no op prec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss	Soil Erosion Loss
30	Not a brine damaged site.										

Site 30-The owner of the land where this site was located explained that he had scraped the topsoil off of it in order to fill in a drain tile ditch. He explained that he did have salt damaged areas in the same field, but that this particular site was not salt damaged. He also mentioned that as recent as the spring of '80 the stream which passes through his property contained the usual opaque salty water.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1052)

N

Scale in Feet

0 660 1320 1980

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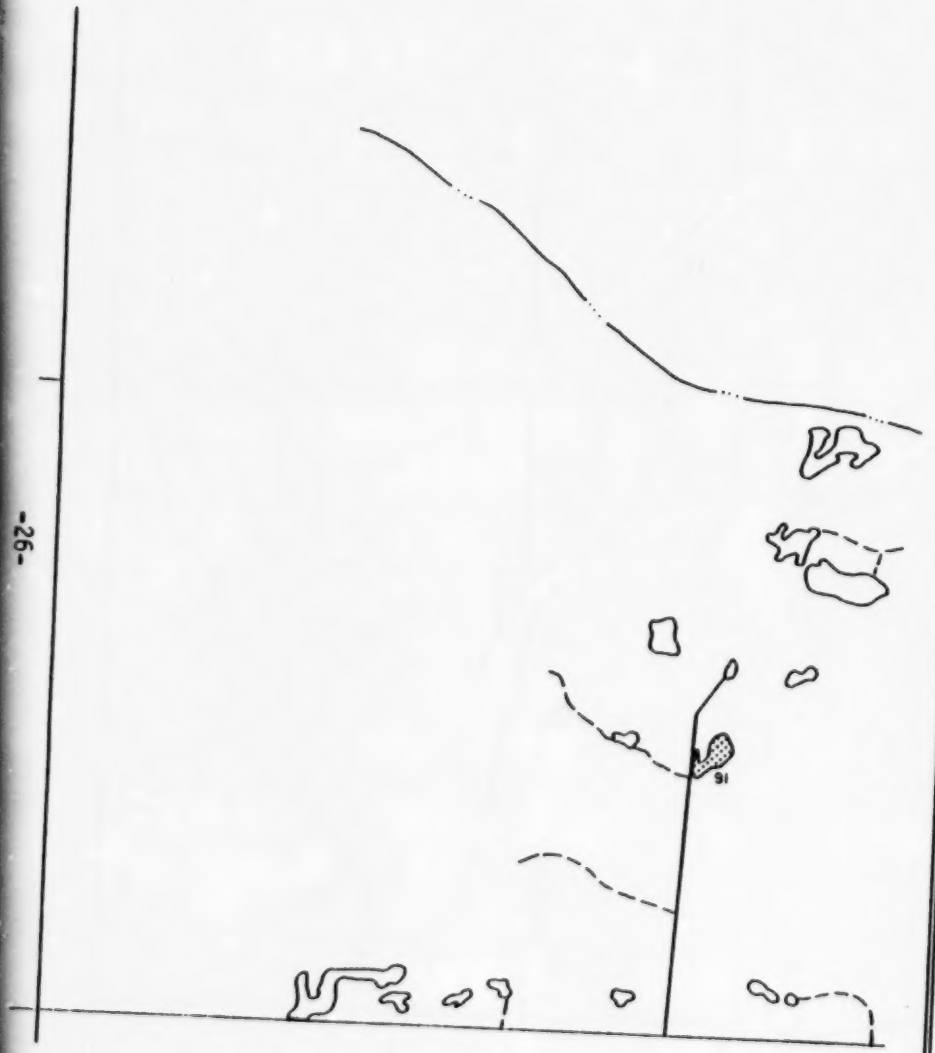

T6S-R5E Section 16

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div (B bare N no up sec. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss	Soil Erosion Loss
91	.7	A	.7	50%B 50%N	.8 .24	.52	70	8	2.2	135.7	95.(

Site 91-This site is located in a field of mixed grasses. Many gullies were present, the largest measuring 8' across, 4.6' deep, and 250' long. This was an old site because the service road was almost indistinguishable. The lower reaches of the site were moist so the possibility of a leaking pipe exists. Several pipes were exposed due to extensive erosion.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

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Scale in Feet

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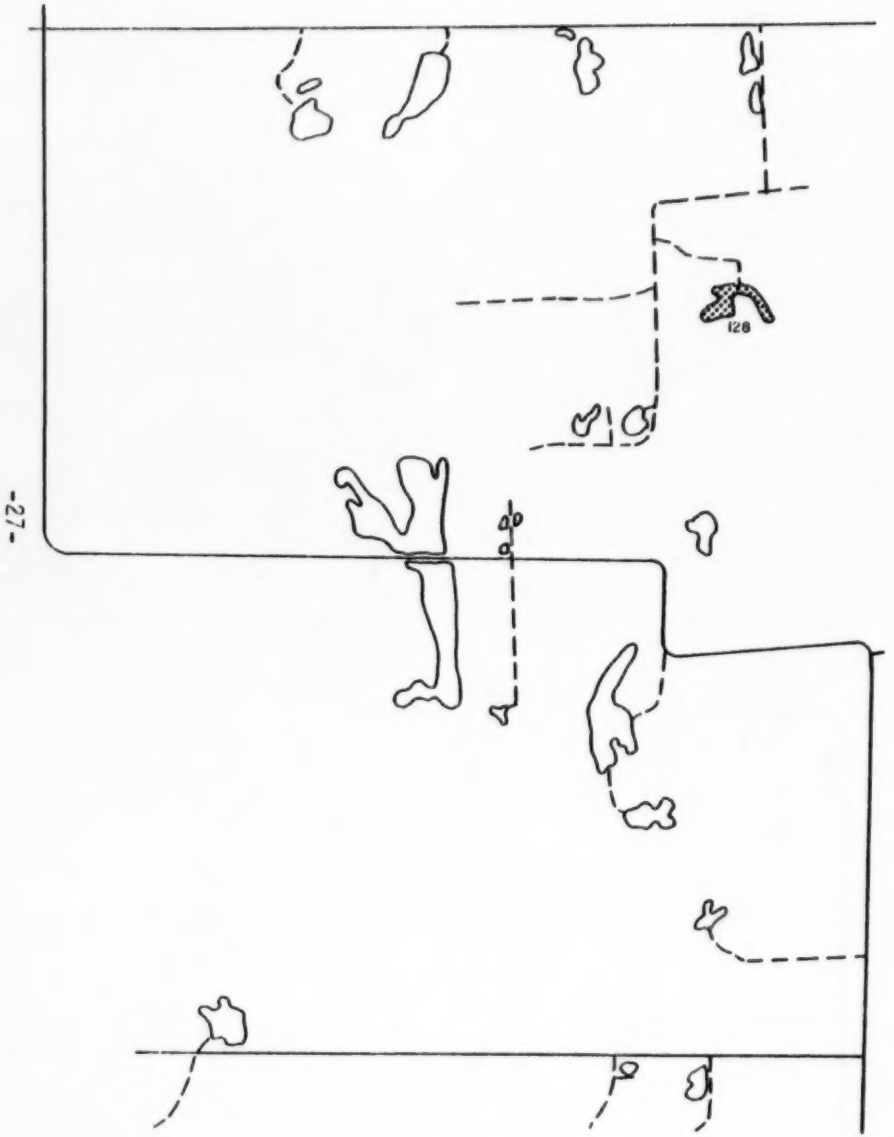

T6S R5E Section 21

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div (B bare N no ap. veg. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
128	.6	A	.6	50%B 50%N	.8 .45	.62	210	9	2.0	150	90

Site 128-This site contains an active well and set of storage tanks. It is also considerably larger than what was outlined from the aerial photos. The area around site is densely vegetated with weeds and short trees.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

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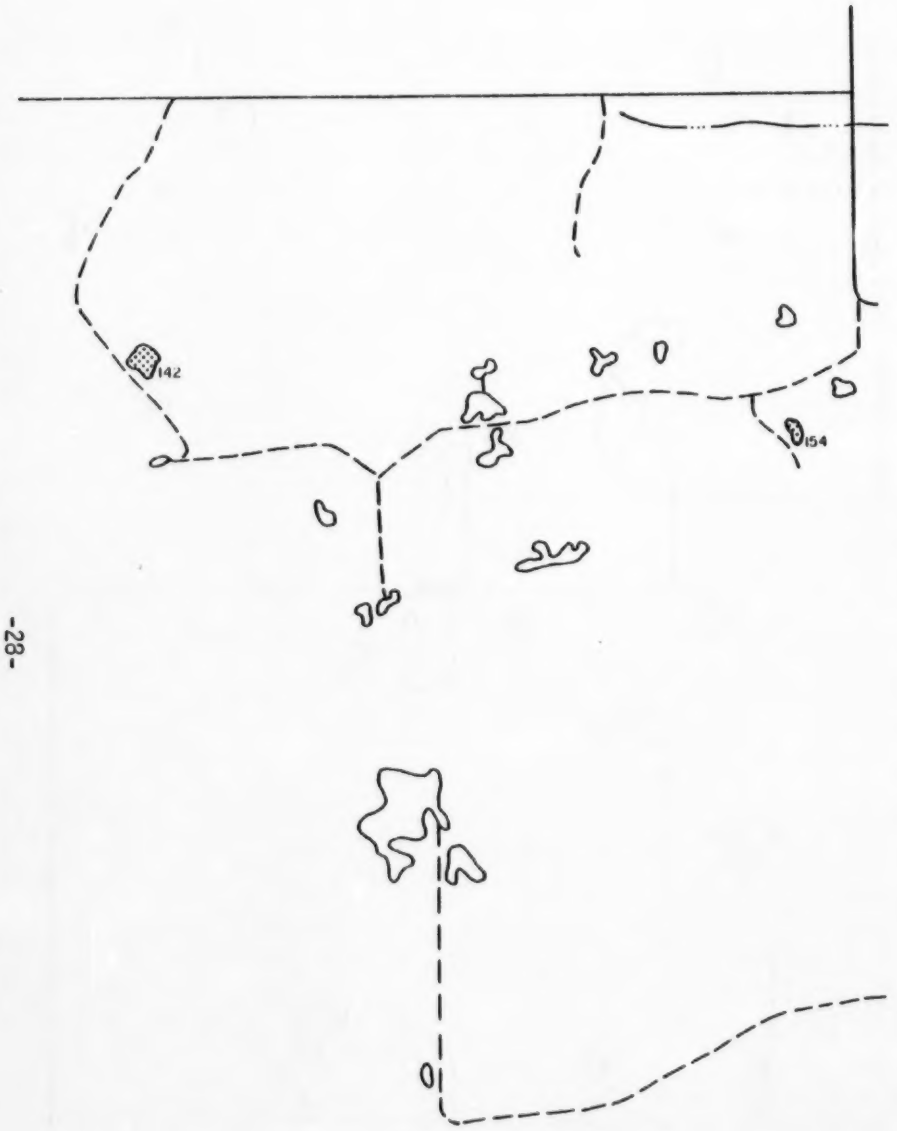

T6S-R5E Section 28

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N no ap prec canopy	"C" Factor	Com-posite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/Ac/yr)	Soil Erosion Loss (tons/site/yr)
142	This is a brine storage pit.										
154	Not a brine damaged site.										

Site 142-This site is an active brine storage pit with active wells in the immediate area. The vegetation on the containment walls surrounding this pit are densely foliated with small trees and mixed grasses. There were no signs of seepage through the walls. This is a fine example of a properly built and maintained brine storage pit.

Site 154-This site is a pond located on an abandoned farm along a service road. It appears to have been a pond inside a hog pen with no visible signs of salt brine storage or damage. Other salt affected areas and active wells exist in the near vicinity.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

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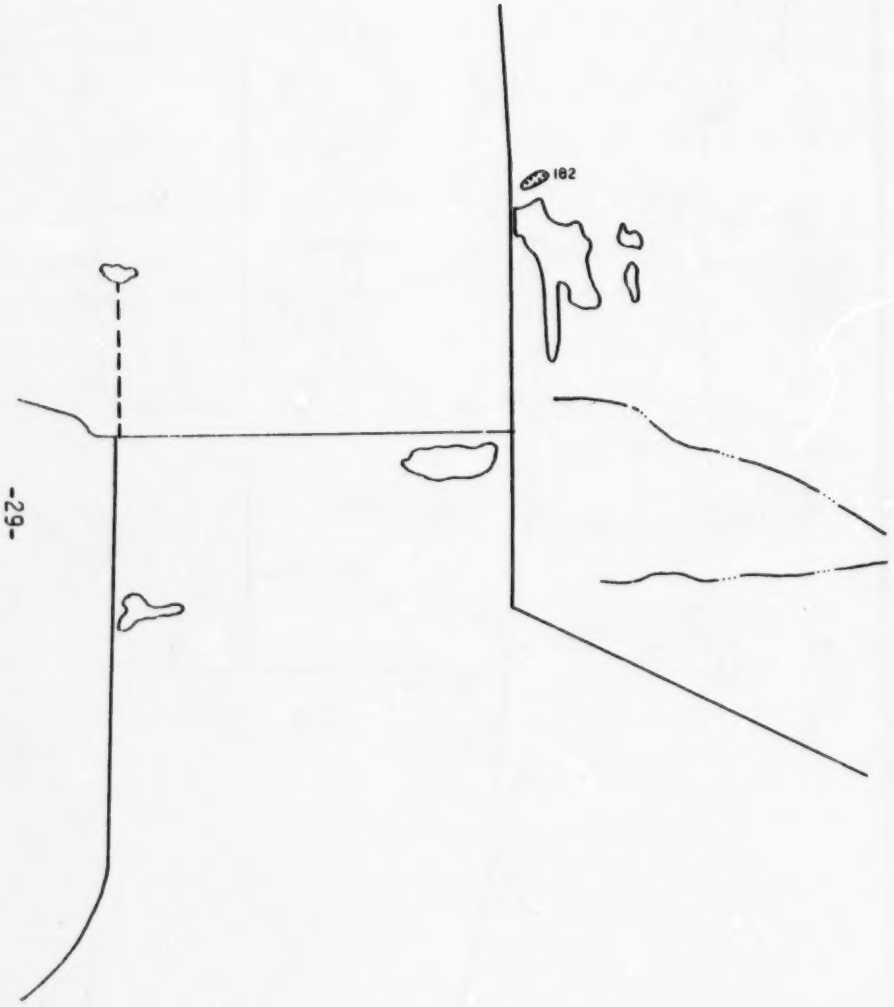

T7S-R5E Section 4

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N no cp prec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/sae/yr)
182	.2	A	.2	100%B	.8	.8	90.0	2	.2	19.4	3.8

Site 182-This site is in a soybean field. Some stunted bean plants are growing around the perimeter but the affected area is very distinct. Several other damaged sites exist in the immediate area.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

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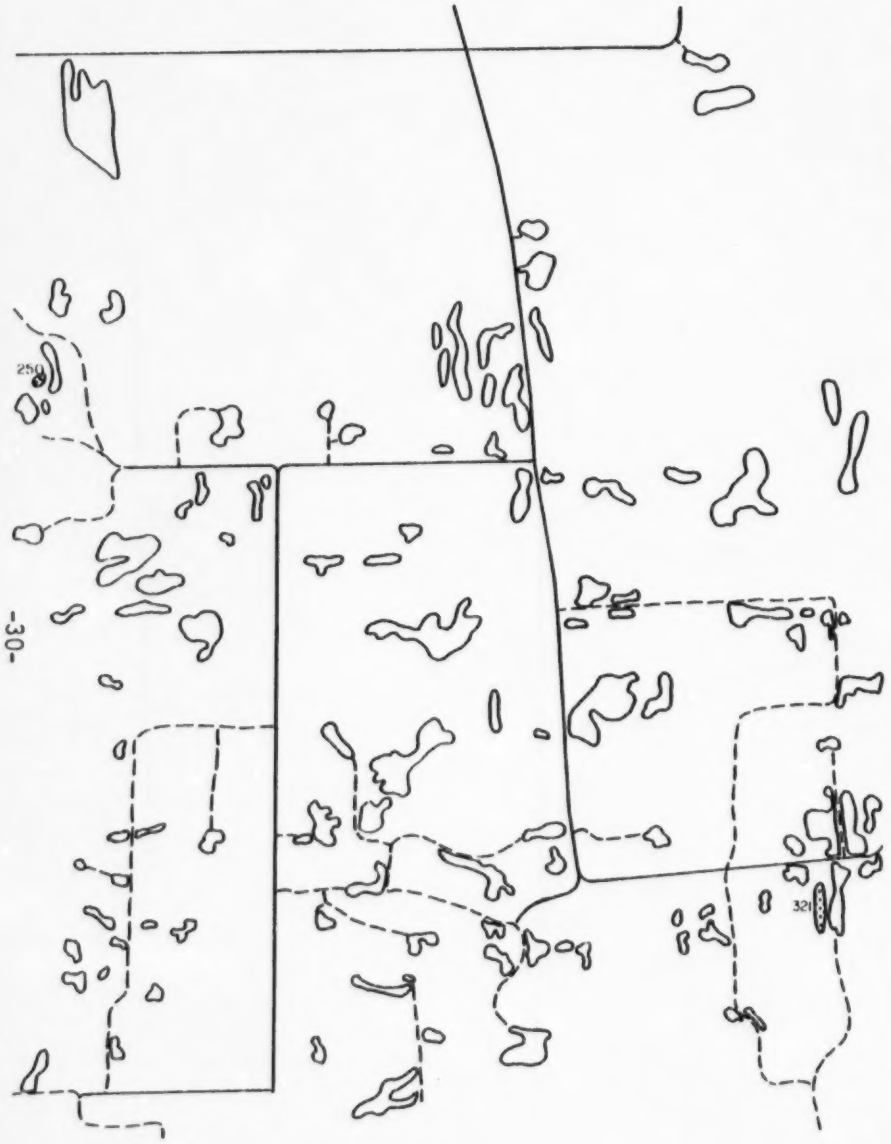

T6S-R5E Section 12

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no op spec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
250	.1	A	.1	55%B 45%N	.8 .24	.54	152	8	1.2	78.4	7.84
321	.3	A	.3	100%N	.15	.15	77	1	.12	2.17	.65

Site 250-Site is located at edge of cornfield and appears to be an old brine storage pit. Mixed grasses have spread throughout the damaged area but motorcycles have disturbed the surface causing salt concentrated soils to mix with surface layers. The result was a new loss of cover and contamination of a large area of ground.

Site 321-This site is sparsely covered with mixed weeds as compared with the surrounding vegetation. An oil or brine transport line existed and ran the full length of the site.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

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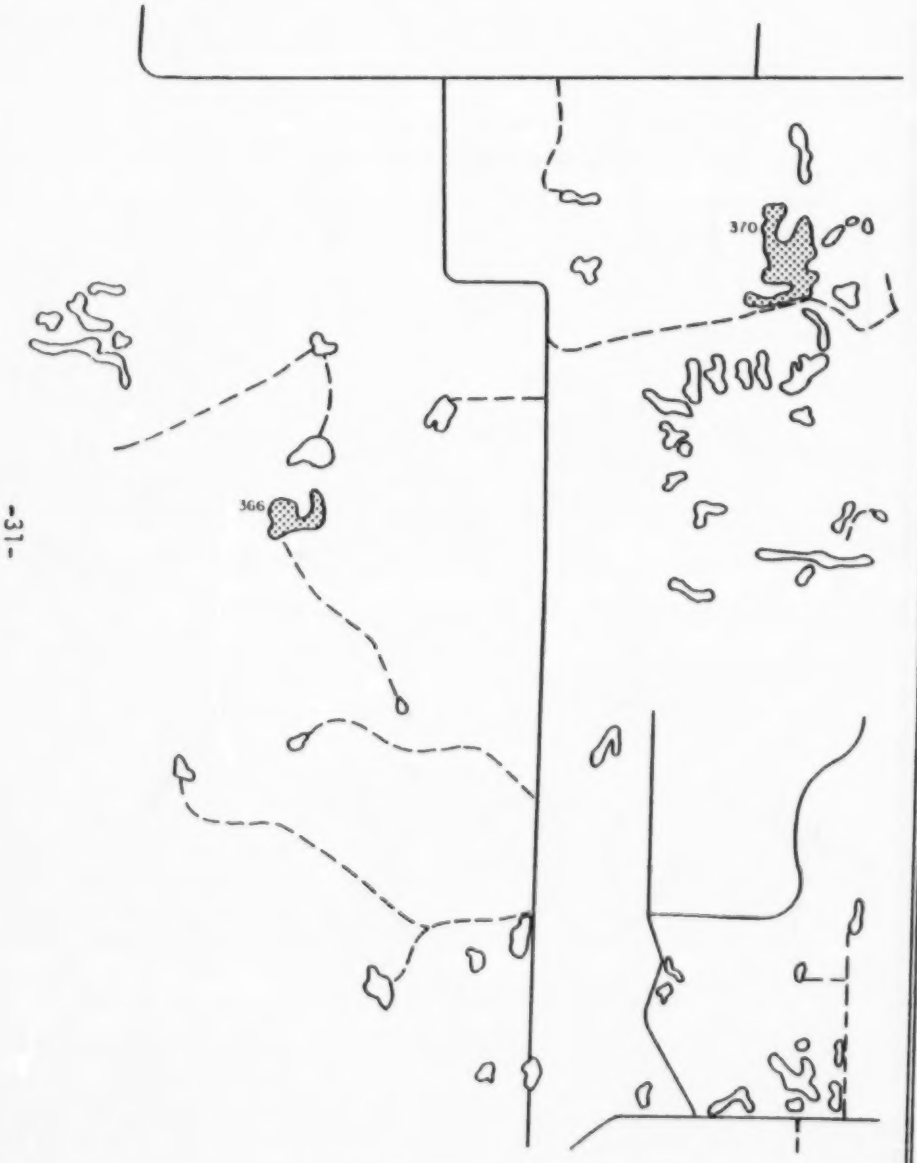
GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R5E Section 11

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no ap. pres. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss	Soil Erosion Loss
366	.8	A	.8	50%B 50%N	.80 .24	.52	141	5.0	.63	38.8	31.1
370	2.6	A	1	10%B 90%N	.8 .091	.28	290	3	.4	14.5	14.5
		B	1.6	5%B 95%N	.8 .091		500	8	2.2	2129	3407

Site 366-This site was in a heavily wooded area. No trees grew on the site. An estimated 30% of the barren sheet and rill division was gully erosion. The largest gully measured 10 ft. wide, 4 ft. deep, and 90 ft. long.

Site 370-This site is made up of soybean field and cow pasture. An old brine storage pit exists with cattails and aquatic weeds flourishing along its edges. Majority of site has no appreciable ground cover and the remainder is barren with no residual plant material. The whole area regardless of slope has gully erosion.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

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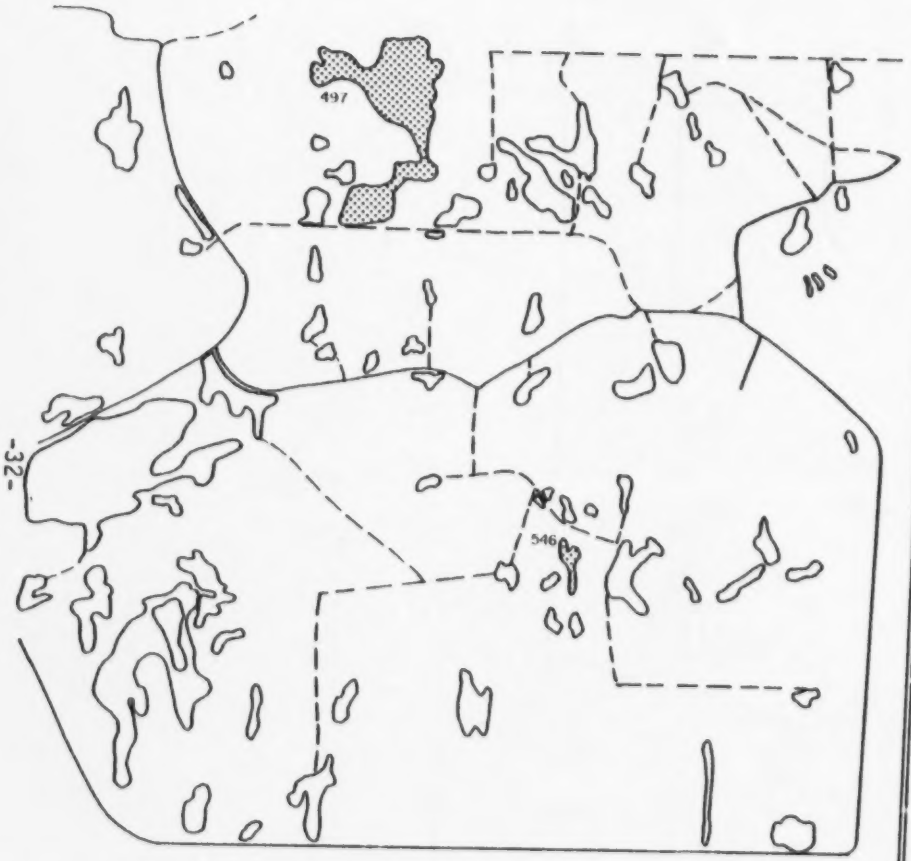

T6S-R5E Section 13

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N-no ap sec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss	Soil Erosion Loss
497	9.7	A	9.7	95%B 5%N	.8 .24	.77	370	10	2.8	2609	2530
546	.4	A	.4	100%B	.24	.24	80	1.0	.12	3.48	1.40

Site 497-Located on this site are 3 storage barrels and a separator tank. These are located atop a ridge with barren soils extending its full length. The damaged areas extend into both the forest and mixed grasses surrounding the site. One storage barrel is leaking brine and has been since the site was first surveyed in early May.

Site 546-This site had Fragmeitis (reed grass), willows and honeysuckle growing on it and around it. A greater area around this site appears to have been damaged or otherwise cleared but has regenerated itself.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

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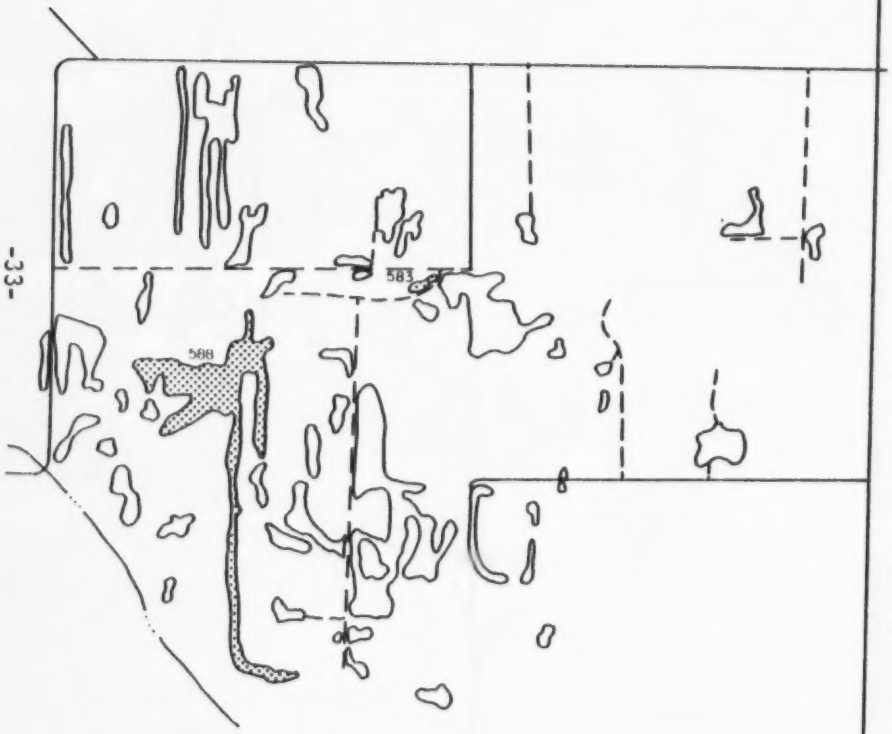
GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R5E Section 24

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-burned N-no appreciable canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/Ac./yr)	Soil Erosion Loss (tons/site/yr)
583	.2	A	.2	100%N	.24	.24	144	0.5	.11	3.19	.63
588	6.5	A	6.5	80%B 20%N	.8 .24	.68	470	1	.21	17.30	112.3

Site 583-This site is an abandoned well site and it is located along a service road. The surrounding vegetation is Camphor which is typical of older salt damaged areas.

Site 588-This site is around an abandoned brine storage pit which appears to be main cause for the damage. Residual oil and crystalized salt appear on the surface of site. The site is located along a cornfield and several large trees are dead along the site edge.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

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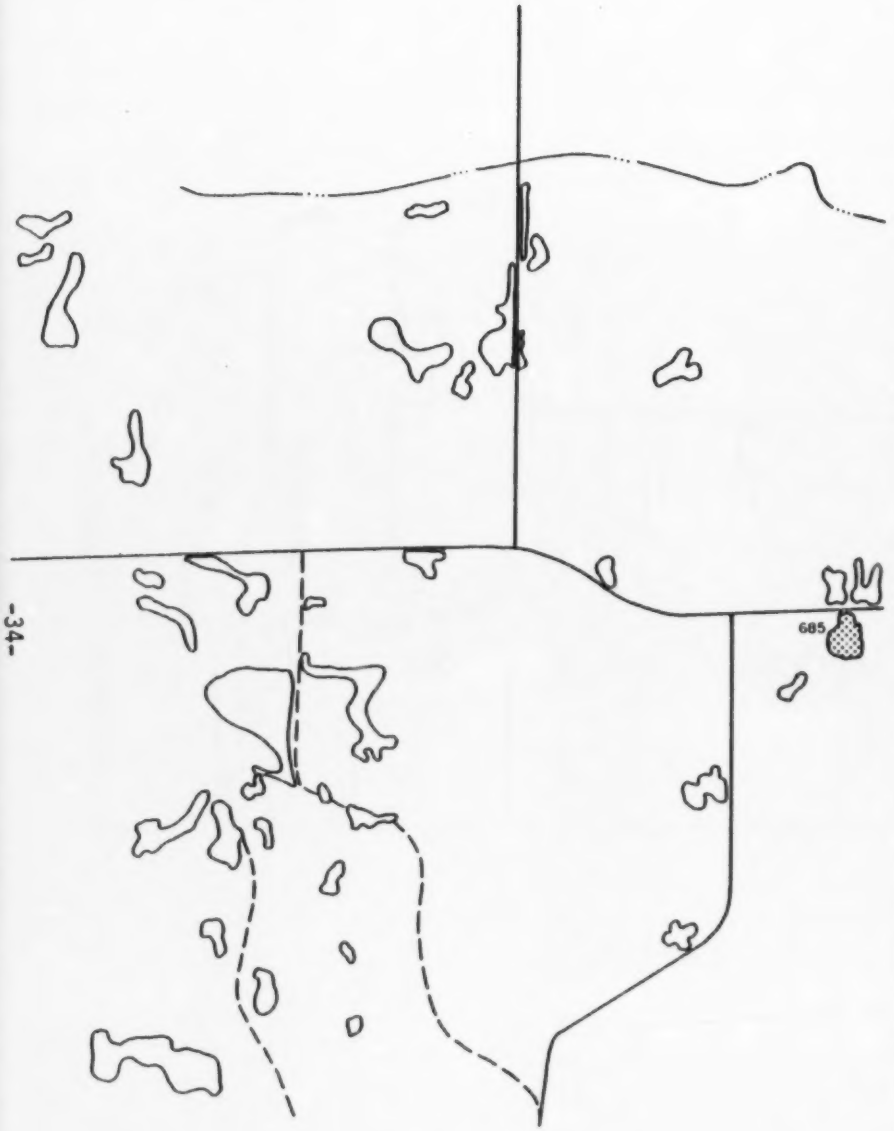
GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R5E Section 26

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N-no ap prec canopy	"C" Factor	Com-posite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
685	1.0	A	1.0	100%B	.8	.8	180	3	.34	32.9	32.9

Site 685 - Extensive damage to forest land exists on this site. Loss of trees is partially due to a fire, but majority of area is salt damaged. There exists evidence of a fresh spill or leakage from the tank battery.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

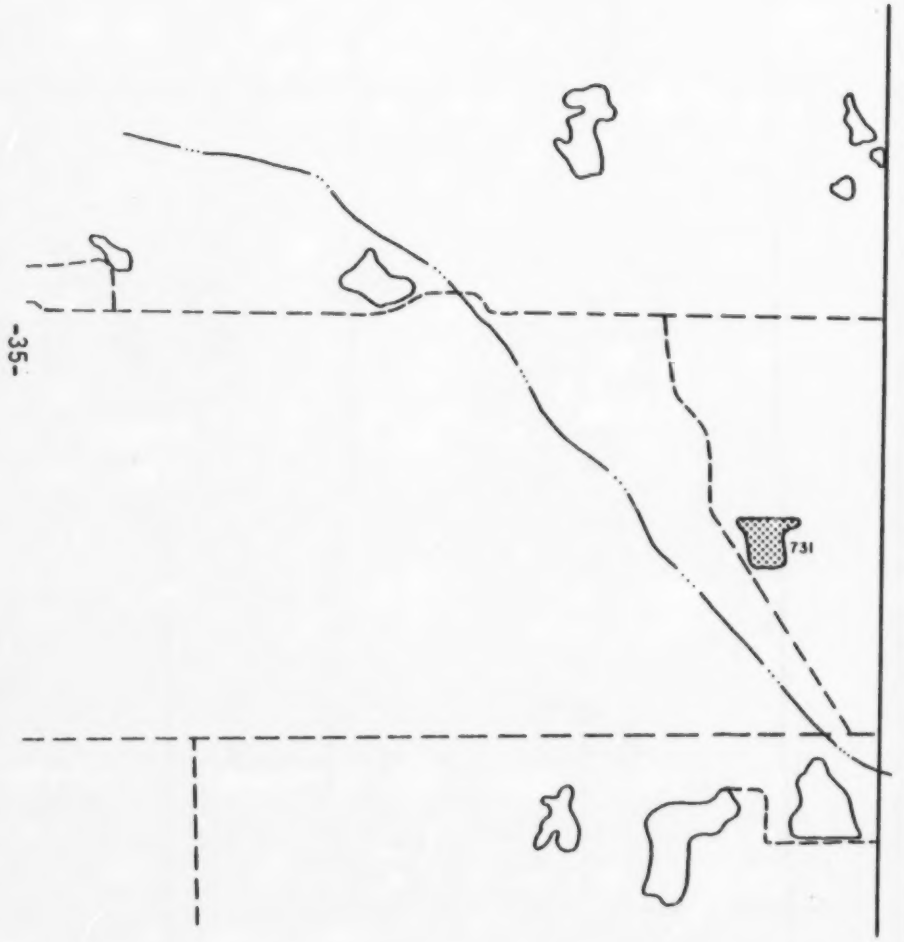
Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no appr. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
731	Not a brine damaged site.										

Site 731-This site is a watering pond for cattle. The landowner explained that the storage tanks uphill from his pond have leaked brine into it but no ill effects were noticed in the cattle.



T6S-R5E Section 36

LEGEND

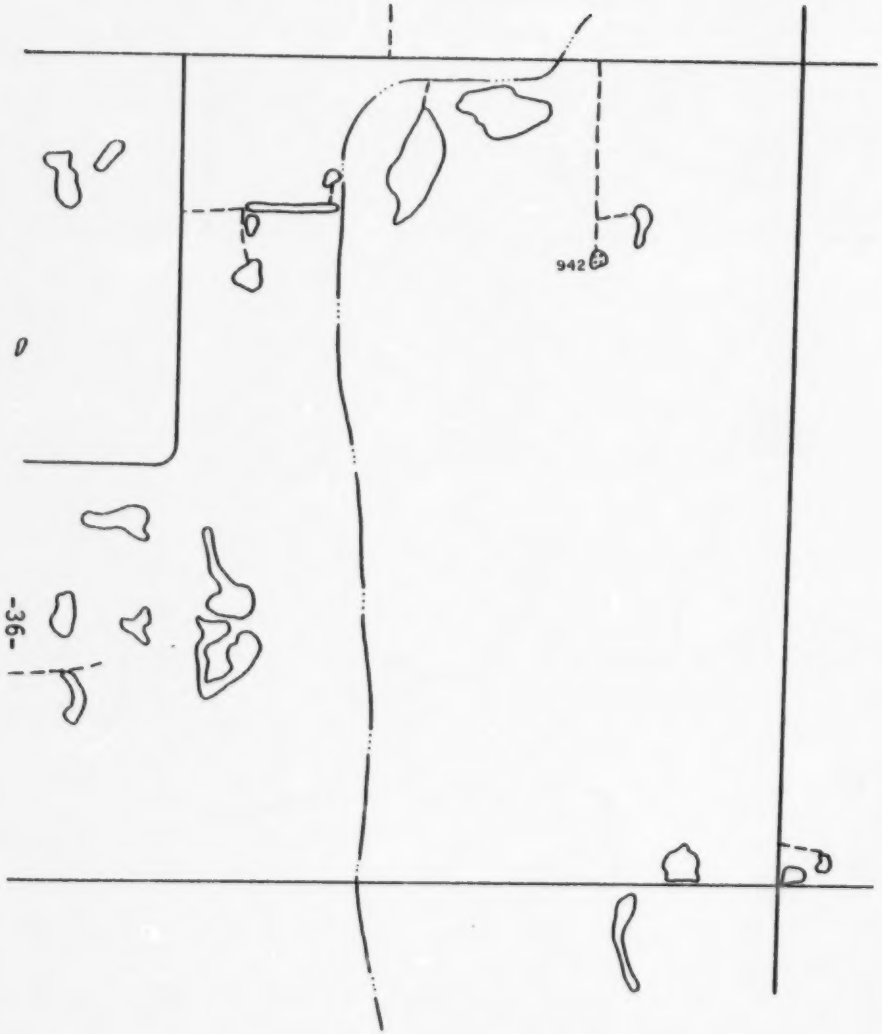
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R6E Section 17

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N no appr canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
942	.2	A	.2	80%B 20%N	.8 .24	.68	147	4	.47	38.67	7.73

Site 942-The site is located in a soybean field at the end of an abandoned service road. From markings in the soil it appears that some of the brine entered the site by runoff from the service road. Additional brine leaked through or over a poorly constructed retaining wall which surrounds a tank battery.

LEGEND

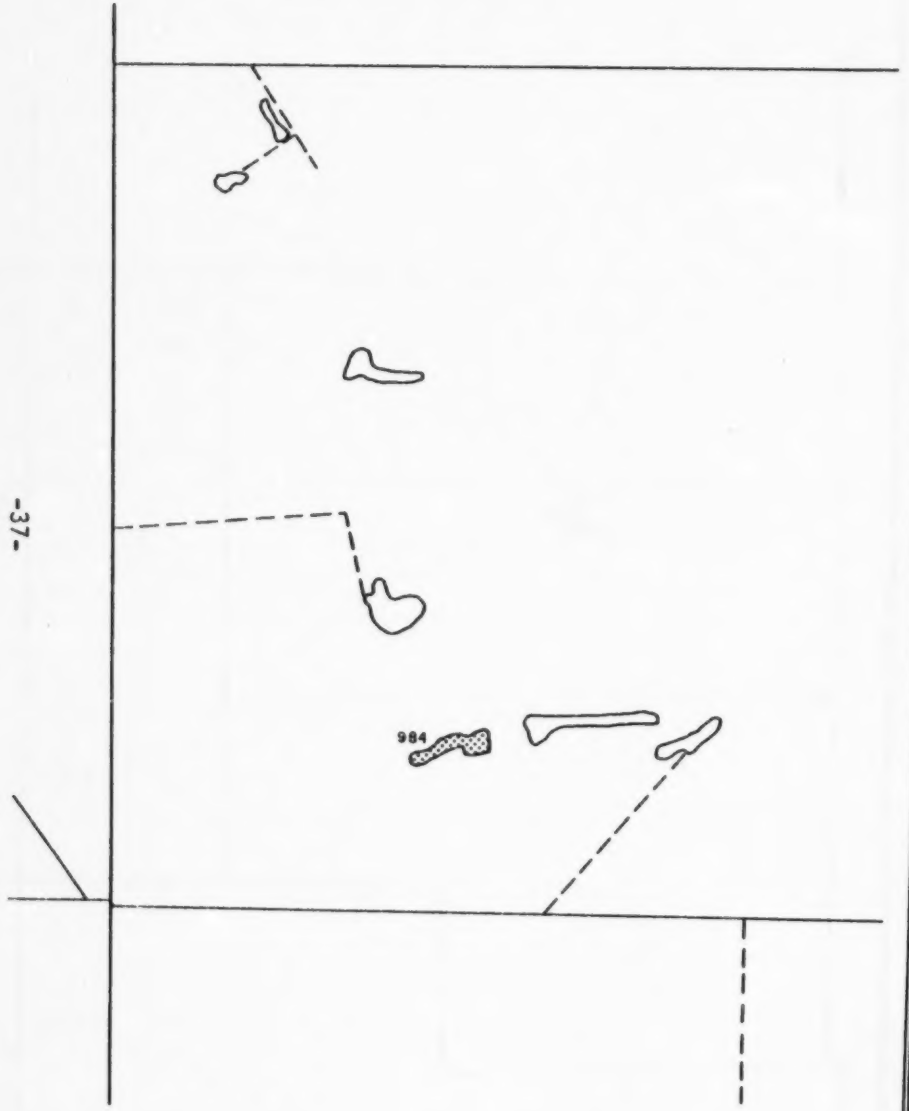
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R6E Section 31

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no up-land canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss	Soil Erosion Loss
984	.6	A	.6	100%N	.10	.10	120	1	.14	1.7	1.0

Site 984-This site is in a hay field. Hay grew and was cut over this site, but the area was distinguishable because of the high percentage of exposed soil.

LEGEND

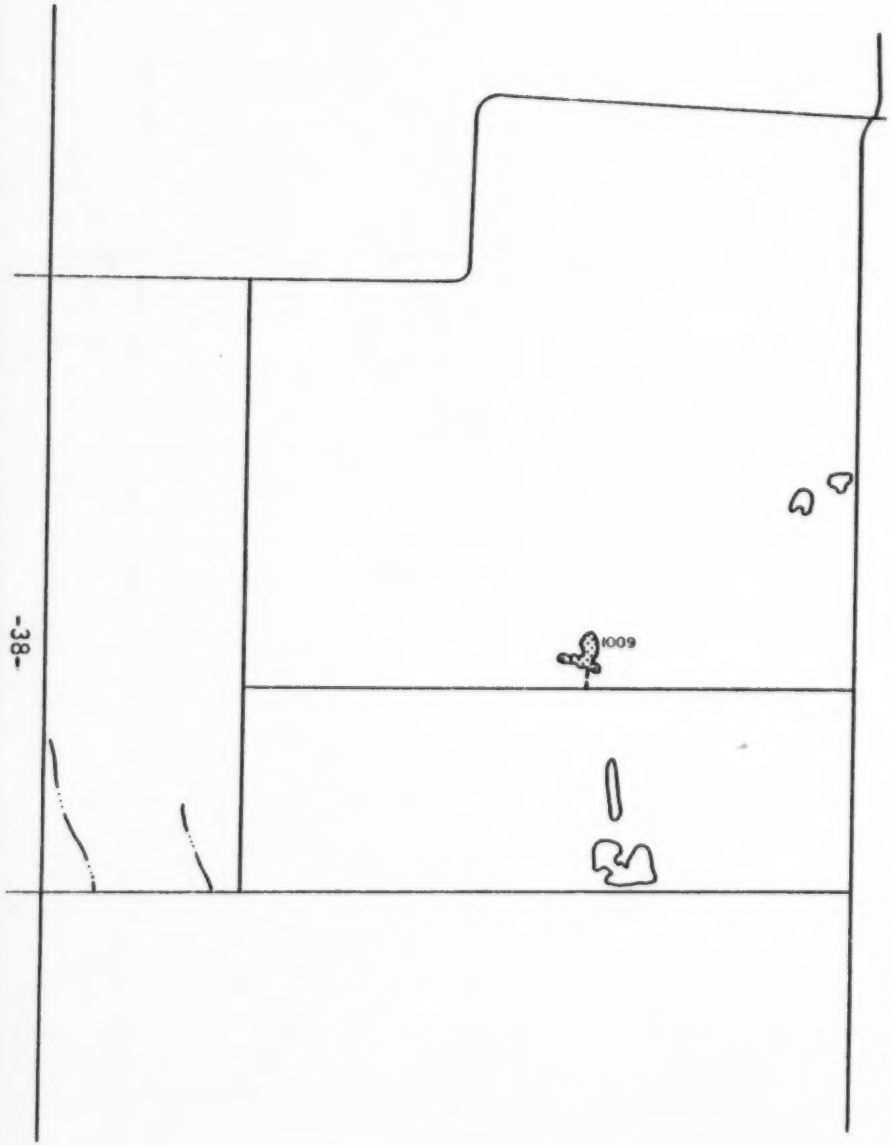
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T4S-R6E Section 3

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. (B-barren N-no ap prec canopy	"C" Factor	Com-posite "C" Factor	Length of Slope (in feet)	Percent Slope	"L.S" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
1009	.5	A	.5	20%B 80%N	.8 .24	.35	112	1	.13	5.50	2.75

Site 1009-This 1/2 acre site was damaged and is supporting a stable plant cover. The landowner spread mulch onto the area and cultivated it. This reclamation process mixed a layer of high salt concentrated soil with the upper layer of lower salt concentrated soil. What remains today is an area with barren soils and limited vegetation. Continued mulching may aid in the leaching of the salts from the soil.

LEGEND

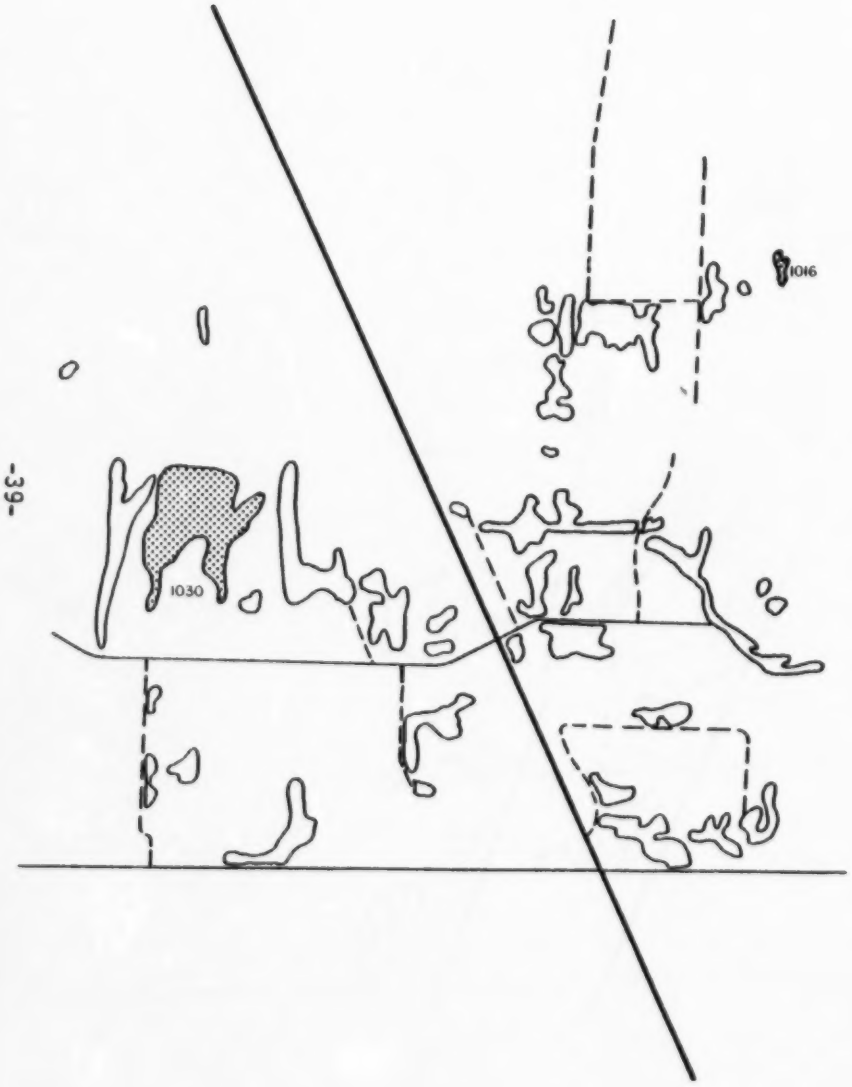
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T5S-R6E Section 27

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no ap. prec. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss tons/ac/yr	Soil Erosion Loss tons/site/yr
1016	.3	A	.3	70%B 30%N	.8 .24	.63	240	1	.16	12.2	3.65
1030	5.8	A	5.8	95%B 5%N	.8 .24	.77	750	3	.53	49.38	286.4

Site 1016-Most of this site is in a cornfield.

Site 1030-Located at the highest point of this site are two active storage tanks, one separator tank and a brine storage pit with an injection pump. Leachate or spillage from the pit appear to be the source of pollution. Moist soil at the bottom of slope has no plant growth. Source of moisture may be where ground water surfaces. This site is now part of a much larger site.

LEGEND

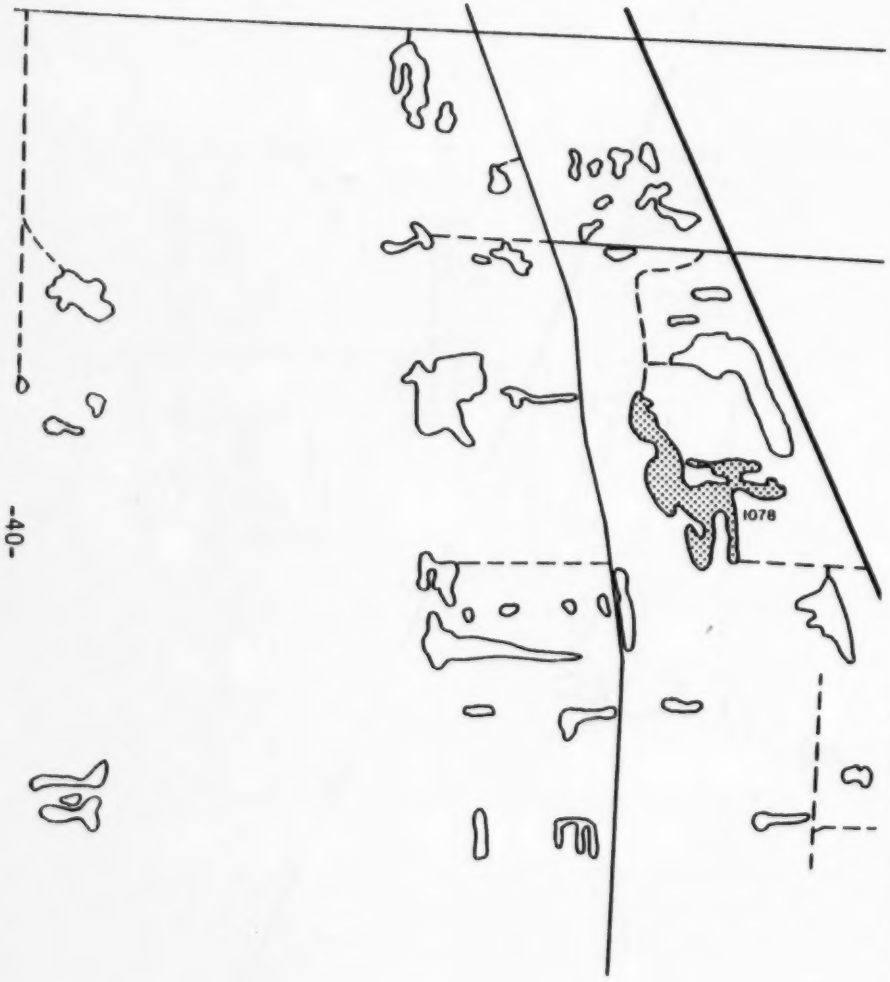
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T5S-R6E Section 34

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N-no ap-preciable canopy	"C" Factor	Com-posite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/area/yr)
1078	4.8	A	2.0	100%B	.8	.8	370	3	.43	41	628
		B	1.0	80%B 20%N	.8 .24	.63	170	2	.34	26.6	86.0
		C	1.8	95%B 5%N	.8 .24	.77	360	3	.42	40.0	70.43

Site 1078-This site has storage barrels and an active well. Recent spills and/or the constant leaking of tanks have created a muddy section of soil down the hill from the tanks.

Site 1077 which is directly north of site 1078, is presently being removed from operation and cleared of debris.

LEGEND

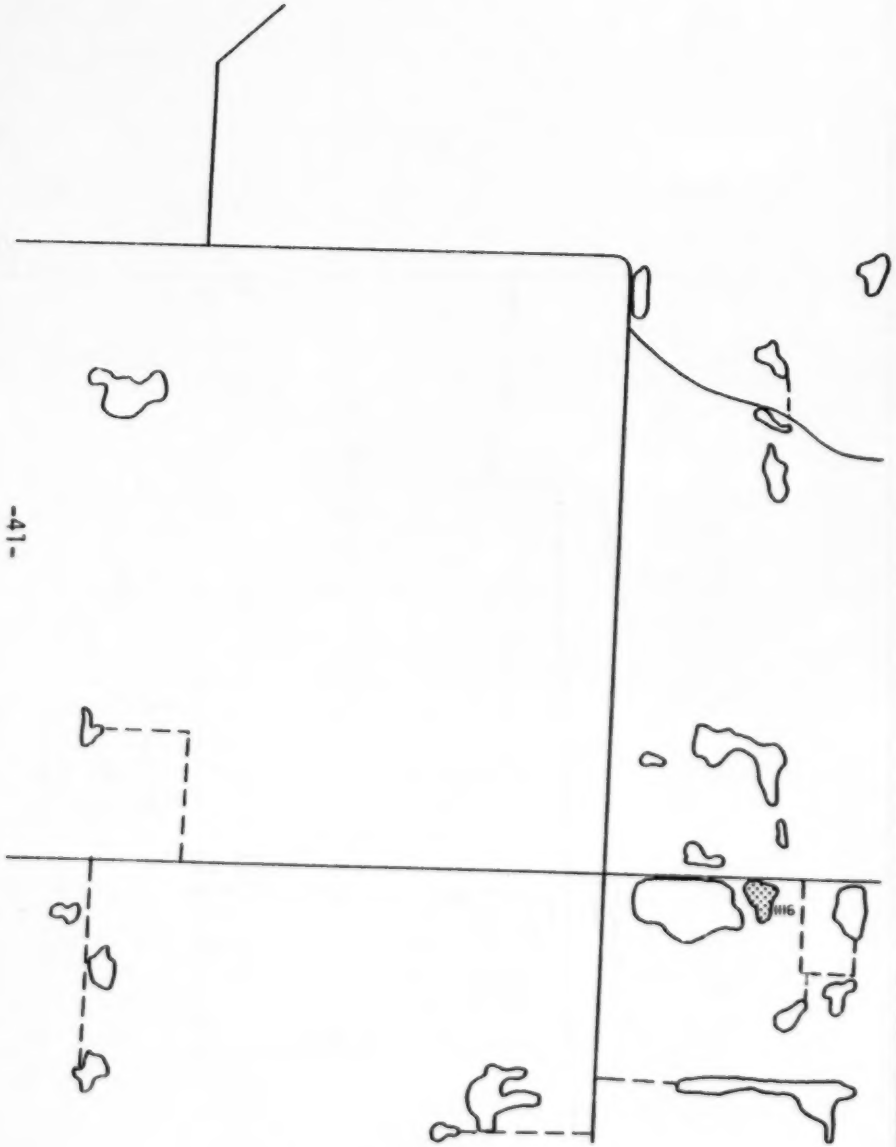
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R6E Section 4

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no op prec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss tons/ac/yr	Soil Erosion Loss tons/site/yr
1116	.5	A	.5	100%N	.45	.45	75	2	.18	9.80	4.9

Site 1116-This site is grown over with a plant which is common to many affected areas. It is known as the Camphor plant. Staff also noted that little organic material existed on the ground around the plants.

LEGEND

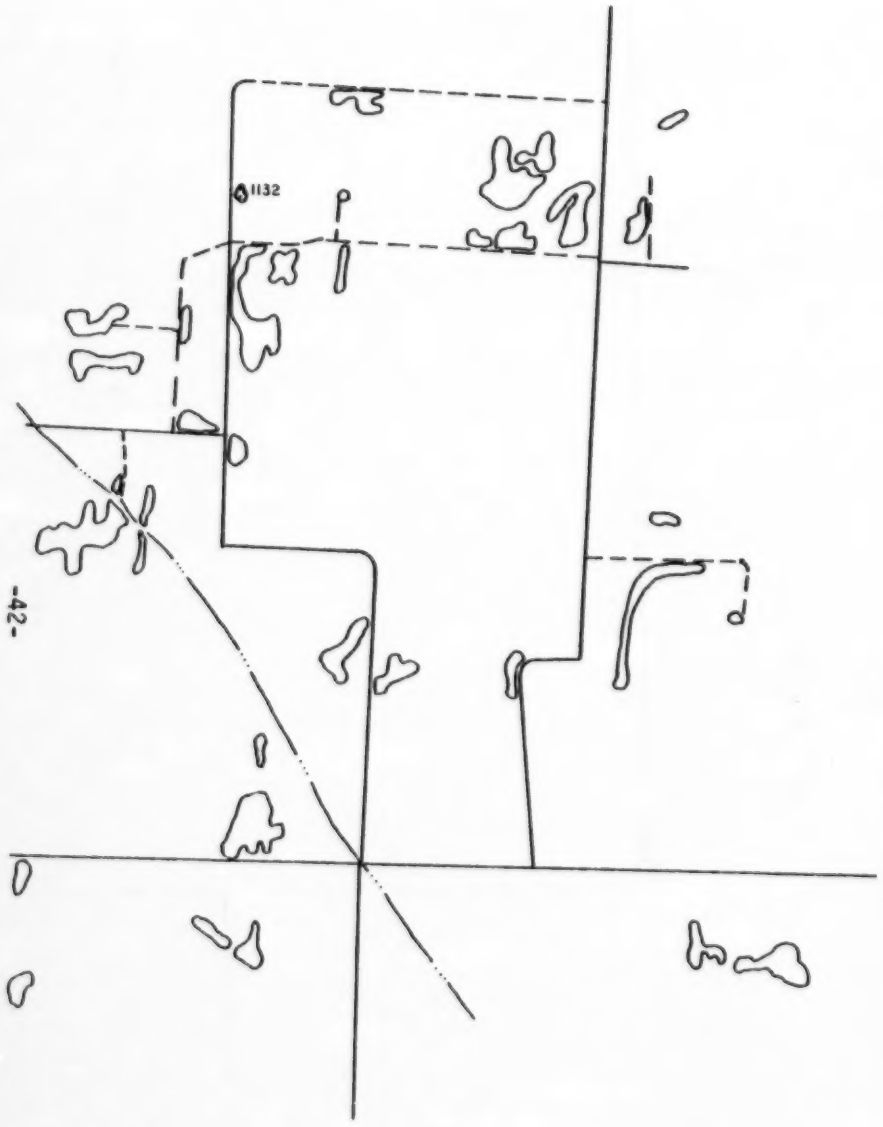
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R6E Section 3

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no ap prec. canopy	"C" Factor	Com-posite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss	Soil Erosion Loss
1132	.1	A	.1	100%N	.24	.24	90	1	.13	3.77	0.37

Site 1132-Site is located in a soybean field at the end of a service road. Soybeans on the site are smaller than those surrounding it and many have wilted.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

T6S-R6E Section 10

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div B-barren N-no appreciable consup	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss tons/ac/yr	Soil Erosion Loss tons/acre/yr
1163	.8	A	.8	90%B 10%N	.8 .45	.76	112	1	.13	12.0	9.5

Site 1163-Site located in middle of corn field.

LEGEND

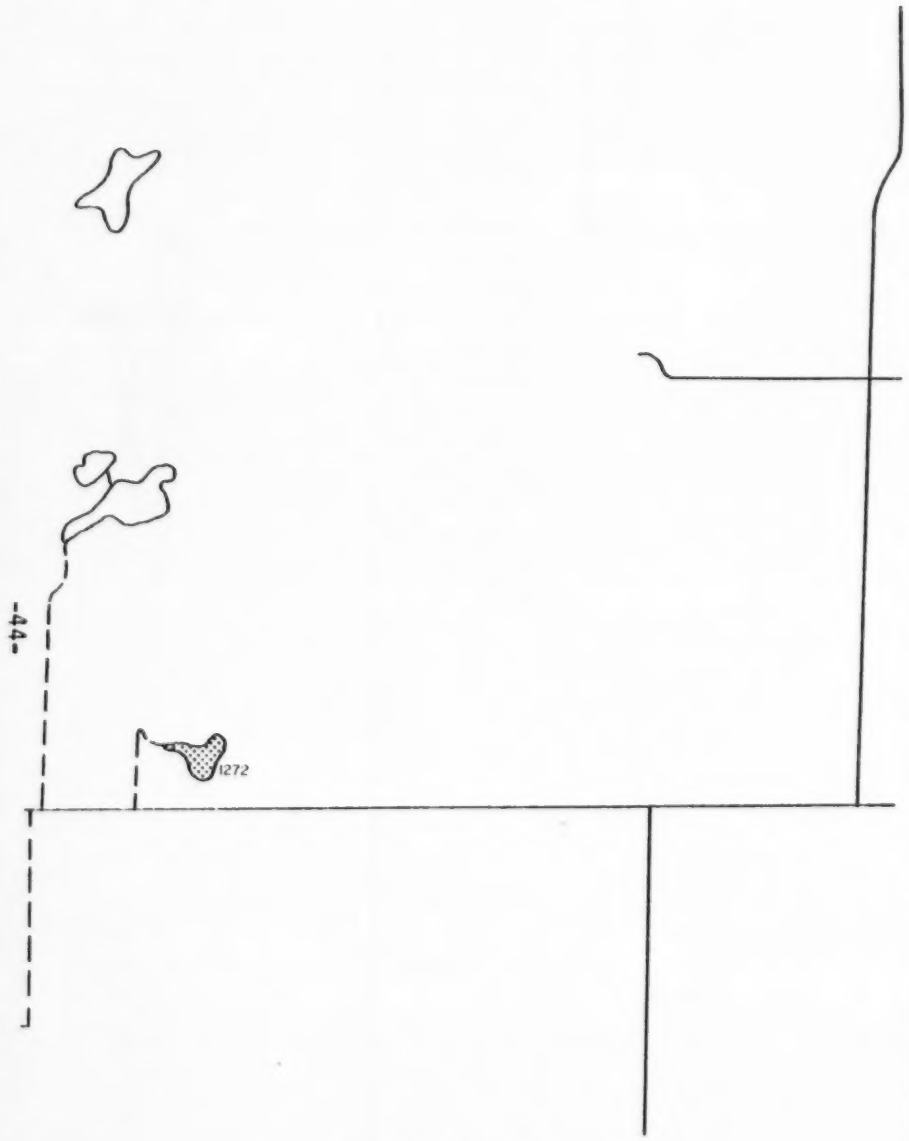
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T7S-R6E Section 3

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B barren N no op. prec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
1272	.9	A	.9	90%B 10%N	.8 .45	.76	120	1	.14	1287	1158

Site 1272-This site located in a soybean field.

LEGEND

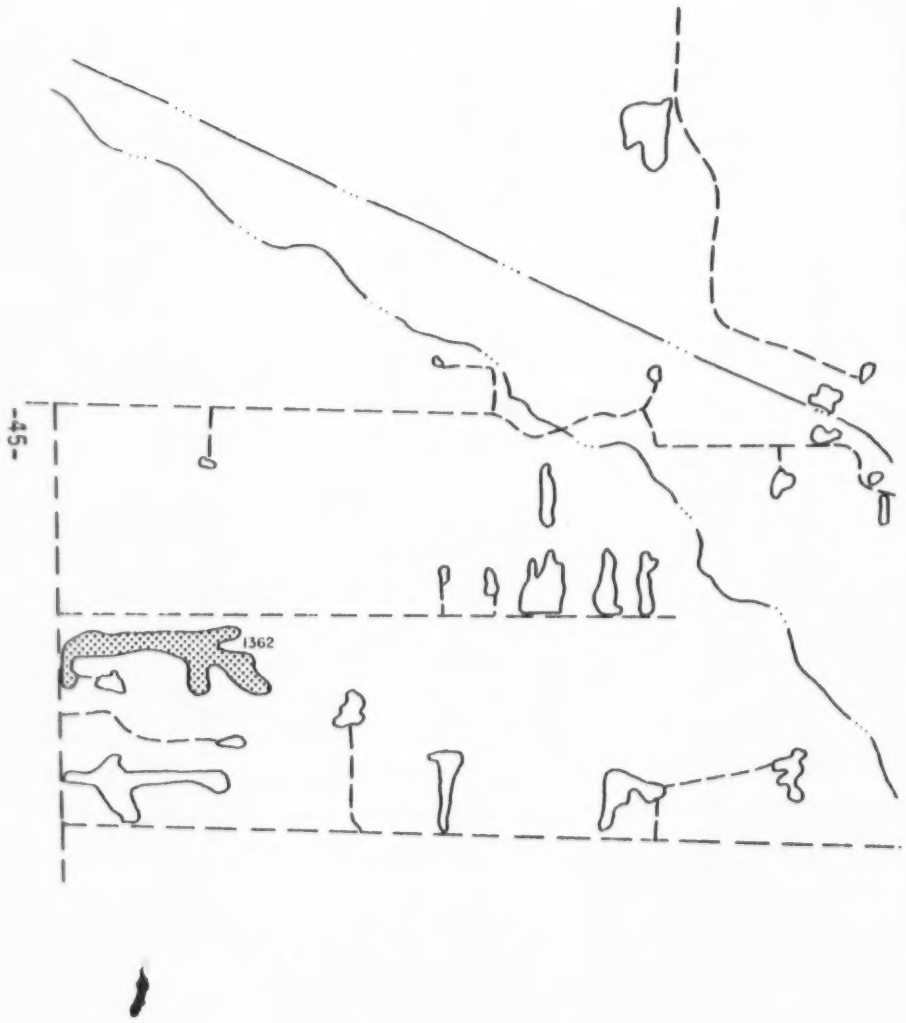
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R6E Section 1

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no ap. prec. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
1362	5.5	A	5.5	95%B 5%N	.8 .45	.78	380	1	.2	18.9	103.8

Site 1362-This site is in a soybean field and borders a wildlife refuge.

LEGEND

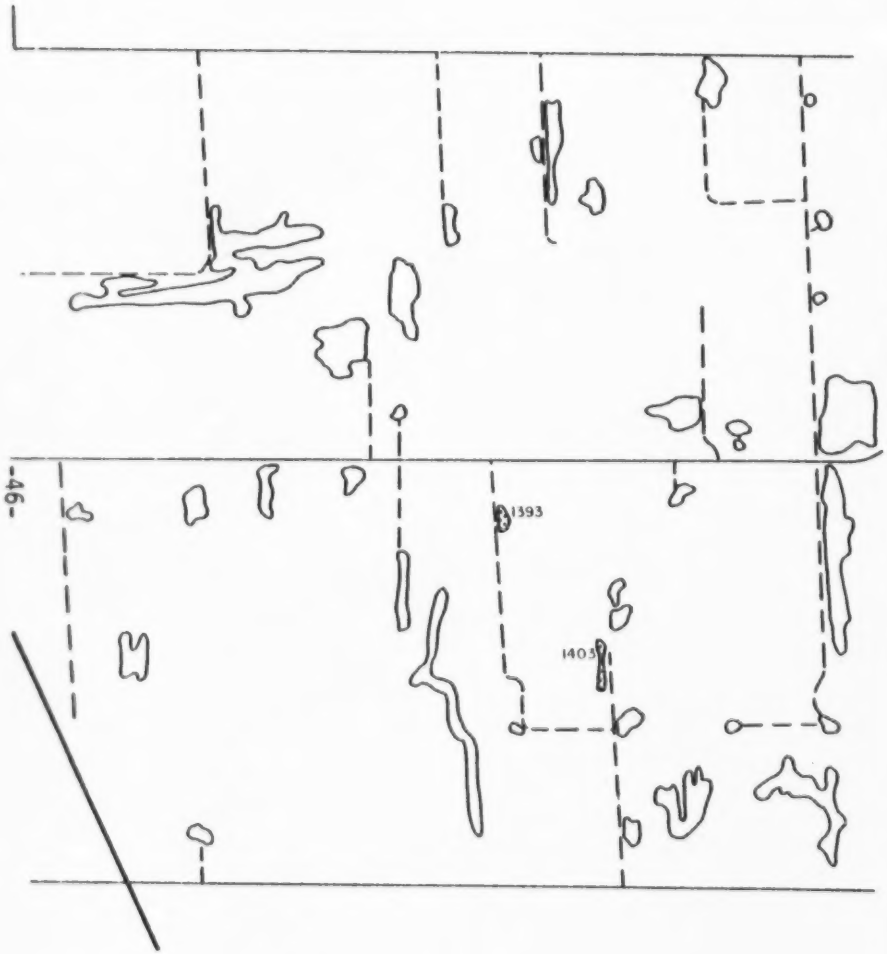
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R6E Section 12

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div B-barren N-no op prec cons	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
1393	.2	A	.2	100%B	.8	.8	80	1	.12	11.6	2.3
1403	.2	A	.2	100%B	.8	.8	90	1	.13	12.6	2.5

Site 1393-A pump is located on this site.

Site 1403-Site is located inside a cornfield. Several rows of corn are dead and stunted. White crystals were on some areas of soil.

LEGEND

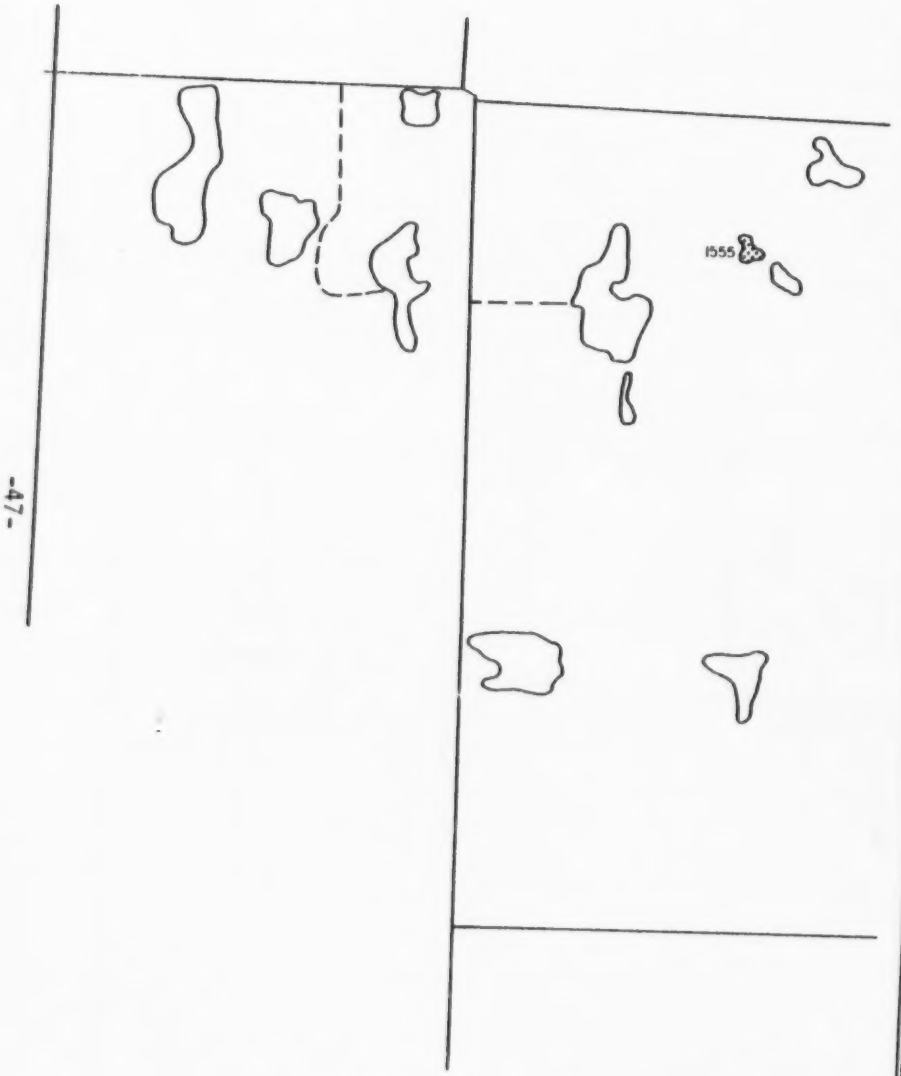
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T4S-R7E Section 20

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no ap prec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
1555	Not a brine damaged site.										

Site 1555-It appears as though the crop was not planted all the way to the edge of the field. This left an area of partially barren soils. Brine damaged soils and tank batteries are located nearby.

LEGEND

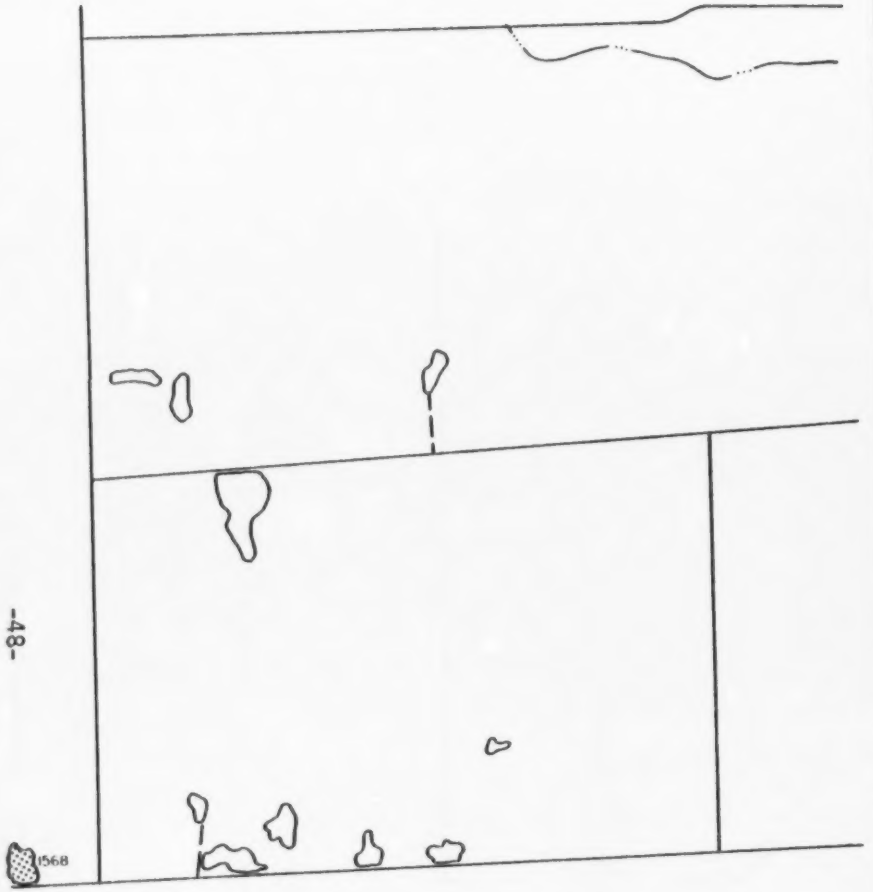
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T5S-R7E Section 31

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no ap. prec. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac./yr)	Soil Erosion Loss (tons/site/yr)
1568	.9	A	.9	90%B 10%N	.8 .45	.76	250	2	.26	23.9	21.5

Site 1568-This site is located in a cornfield. One side of site is a drainage ditch with gullies and with crystals along its banks.

LEGEND

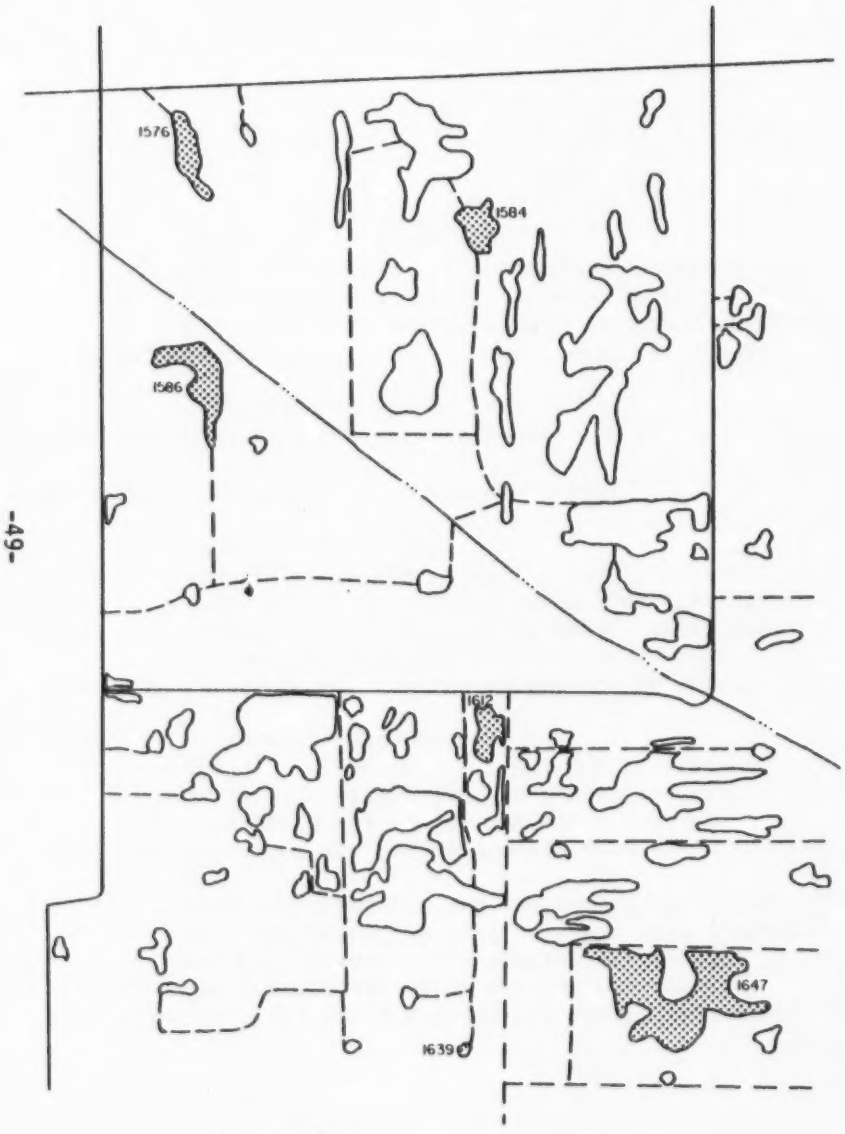
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R7E Section 6

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div B-barren N-no ap-prec canopy	"C" Factor	Com-posite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/Ac/yr)	Soil Erosion Loss (tons/site/yr)
1576	1.2	A	1.2	40%B 60%N	.8 .45	.59	400	1	.20	14.27	17.12
1584	.9	A	.9	80%B 20%N	.8 .45	.73	440	1	.2	17.66	15.89
1586	2.0	A	2.0	75%B 25%N	.8 .45	.71	380	1	.20	17.18	34.36
1612	.7	A	.7	95%B 5%N	.8 .51	.78	220	2	.25	23.60	16.51
1639	.1	A	.1	50%B 50%N	.8 .24	.52	100	1	.13	8.17	.81
1647	7.3	A	7.3	95%B 5%N	.8 .51	.78	390	2	.31	29.25	213.5

See following page for site descriptions.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

Site 1576-This site has 4 storage barrels, 1 separator, and a two-stage brine storage pit system. One pit appears to be leaking via seepage from its retention wall. It was also obvious that the first pit had overflowed its banks.

Site 1584-This site is a major storage area which services 9 wells. In May, staff noticed a small oil spill area. In August, the oil spill was larger and beginning to affect surrounding vegetation.

Site 1586-Having seen this site in May and August, it becomes apparent that vegetation is much slower growing on affected land. There may also be a broken pipe because there is water standing in a low elongated portion of the site.

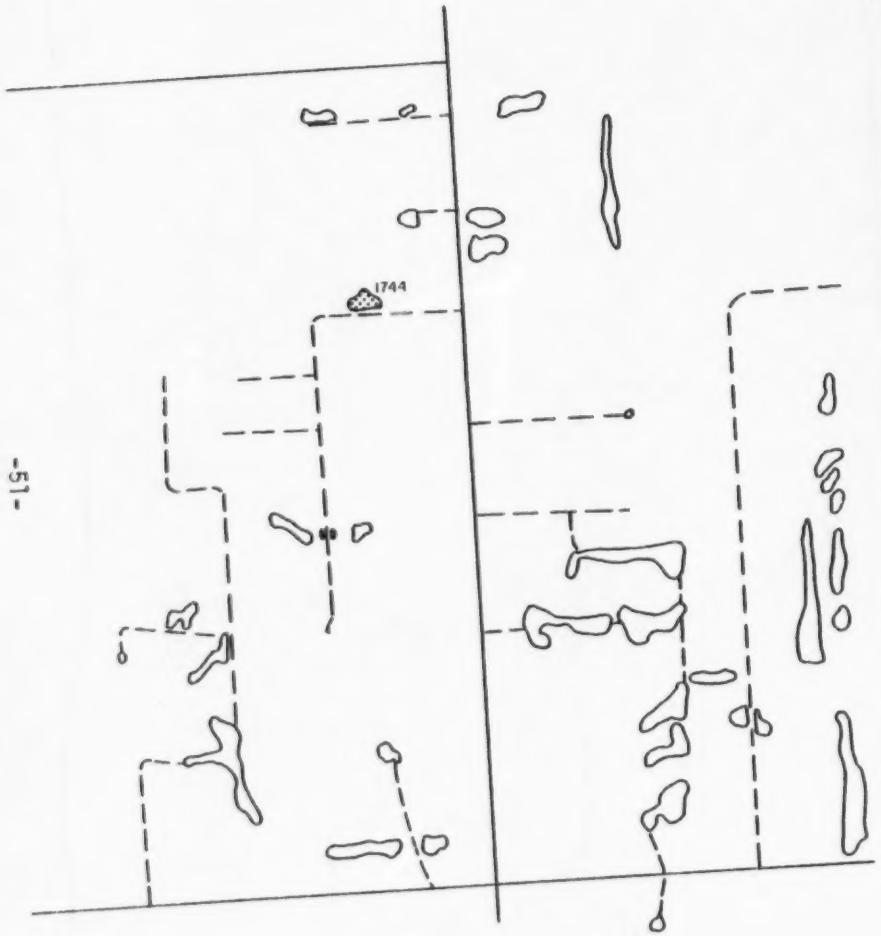
Site 1612-This site is in a soybean field.

Site 1639-This site has an active well and is surrounded by soybeans.

Site 1647-This site is in a soybean field. It appears as though site 1647-1649 have combined through the spreading of brine affected soils or runoff. Portions of this site are being reclaimed with gypsum and possibly drain tiles.

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-bares N-no op prec canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss tons/ac./yr.	Soil Erosion Loss tons/Acre/yr.
1744	.4	A	.4	95%B 5%N	.8 .24	.77	80	1	.12	11.18	4.4

Site 1744-This site is located in a field of mixed grasses.



T6S-R7E Section 18

LEGEND

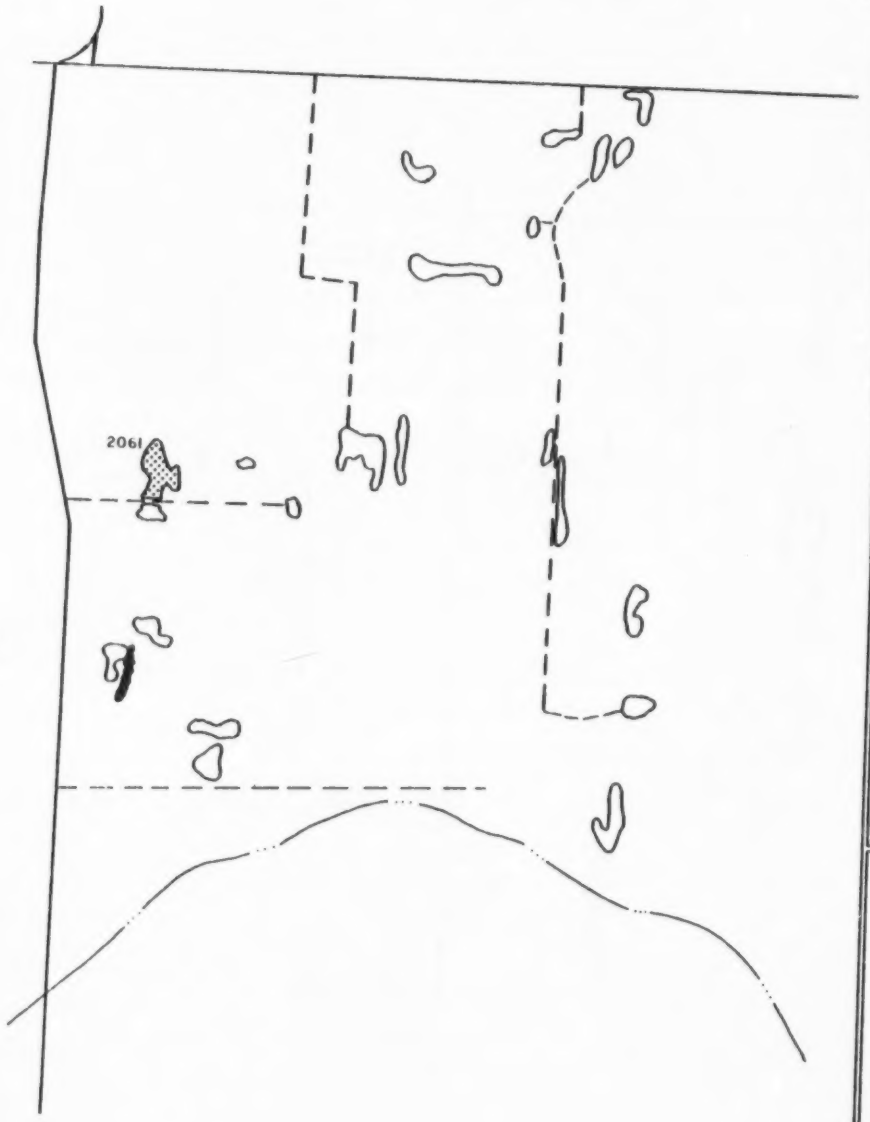
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T4S-R7E Section 23

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div (B barren N-no ap. prec. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/yr)
2061	1.2	A	1.2	10%B 90%N	.45 .8	.48	300	8	1.8	104.5	125.4

Site 2061-This site has a sparse covering of "Camphor" which is a common plant type for brine affected land.

LEGEND

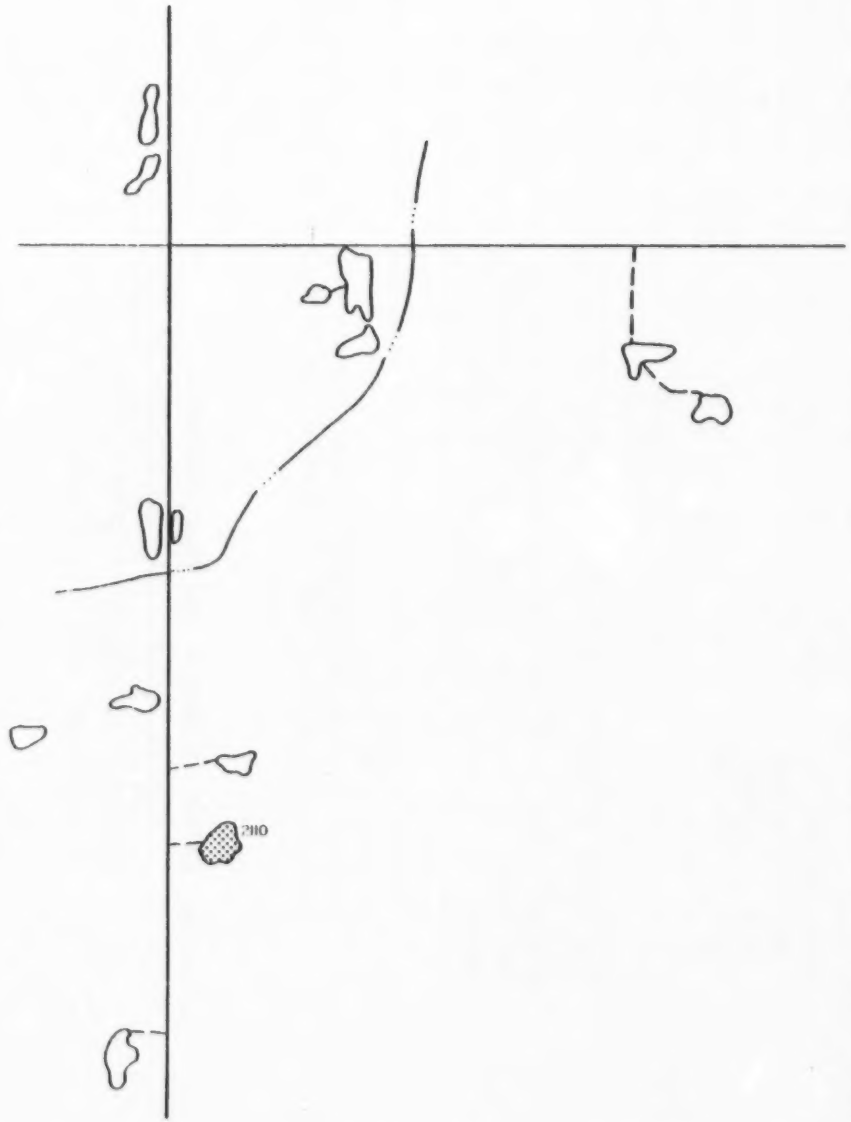
- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- RANDOMLY SAMPLED BRINE DAMAGED SITES (1032)

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION



T6S-R7E Section 26

Site No.	Total Site Size (in acres)	Site Div.	Div. Size (in acres)	Sheet & Rill Div. B-barren N-no appr. canopy	"C" Factor	Composite "C" Factor	Length of Slope (in feet)	Percent Slope	"LS" Factor	Soil Erosion Loss (tons/ac/yr)	Soil Erosion Loss (tons/site/yr)
2110	.9	A	.9	95%B 5%N	.8 .45	.78	230	.2	.10	9.4	8.5

Site 2110-This site is now in pasture. A neighbor explained that the site was recently drilled and operating. Very little vegetation exists and the service road rock has been spread throughout the whole site. Many parts of corroding metal appear on the surface or partially buried.

LEGEND

- MAJOR HIGHWAYS
- SECONDARY ROADS
- SERVICE ROADS
- INTERMITTENT STREAMS
- BRINE DAMAGED SITES
- 1032 RANDOMLY SAMPLED BRINE DAMAGED SITES

N

Scale in Feet

0 660 1320 1980

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

Appendix C

Factor C for Permanent Pasture, Range, and Idle Land[a]

Vegetative canopy		Cover that contacts the soil surface						
Type and height[b]	Percent cover[c]		Ground cover (percent)					
		Type[d]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	0.45	0.24	0.15	0.091	0.043	0.011
Tall weeds or short brush with average drop fall height of 20 in.	25	G	0.36	0.17	0.09	0.038	0.013	0.003
		W	0.36	0.20	0.13	0.083	0.041	0.011
	50	G	0.26	0.13	0.07	0.035	0.012	0.003
		W	0.26	0.16	0.11	0.076	0.039	0.011
	75	G	0.17	0.10	0.06	0.032	0.011	0.003
		W	0.17	0.12	0.09	0.068	0.038	0.011
Appreciable brush or bushes, with average drop fall height or 6.5 ft.	25	G	0.40	0.18	0.09	0.040	0.013	0.003
		W	0.40	0.22	0.14	0.087	0.042	0.011
	50	G	0.34	0.16	0.08	0.038	0.012	0.003
		W	0.34	0.19	0.13	0.082	0.041	0.011
	75	G	0.28	0.14	0.08	0.036	0.012	0.003
		W	0.28	0.17	0.12	0.078	0.040	0.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft.	25	G	0.42	0.19	0.10	0.041	0.013	0.003
		W	0.42	0.23	0.14	0.089	0.042	0.011
	50	G	0.39	0.18	0.09	0.040	0.013	0.003
		W	0.39	0.21	0.14	0.087	0.042	0.011
	75	G	0.36	0.17	0.09	0.039	0.012	0.003
		W	0.36	0.20	0.13	0.084	0.041	0.011

[a]The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[b]Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[c]Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[d]G: Cover at surface is grass, grasslike plants, decaying compacted duff, or litt at least 2 in. deep.

W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Source: Walker, Robert D. and Pope, Robert A., Estimating Your Soil Erosion Losses with the Universal Soil Loss Equation (USLE), Cooperative Extension Service, College of Agriculture, University of Illinois, Urbana, IL, 1979.